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INSTRUCTION MANUAL

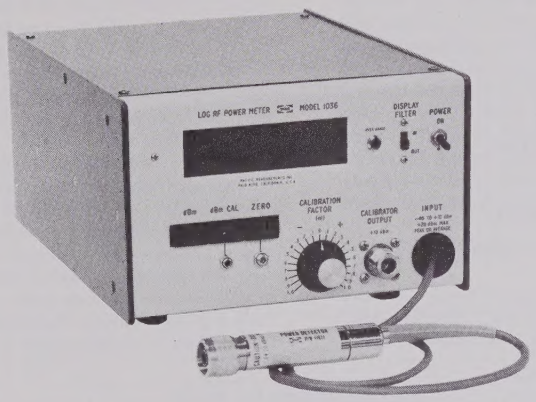
MODEL 1036 AND 1037

LOG RF POWER METER

MODEL 1036
MODEL 1037

PM PACIFIC MEASUREMENTS INCORPORATED

INSTRUCTION MANUAL



LOG RF POWER METER

MODEL 1036
MODEL 1037

SERIAL NUMBER 844

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SECTION 1

GENERAL INFORMATION

1.1 THE PACIFIC MEASUREMENTS MODEL 1036/1037 LOG RF POWER METER.

The Pacific Measurements Models 1036 and 1037 Log RF Power Meters will measure RF power in the frequency range from 1 MHz to 14 GHz. If equipped with detector Part No. 11939 the frequency range is extended up to 18 GHz. A four digit numeric display indicates the power level in dBm with 0.01 dB resolution. Since the measurement is made in logarithmic rather than linear terms, a single scale covers the total dynamic range of the instrument. A four foot cable connects the power detector to the indicator unit. Detector input impedance is 50 ohms. Below 1 GHz, an adapter is available to convert the input impedance to 75 ohms. In the detector head, a microwave diode converts the RF energy to a dc voltage. Since the sensitivity of these diodes is relatively greater than that of thermal detectors, the instrument has a dynamic range greater than 50 dB. The response speed is limited by the permissible signal-to-noise ratio, rather than the time constant of the detector. The speed is adequate to permit viewing swept frequency response curves on an oscilloscope at a rate greater than 60 Hz, using the analog output.

The analog output corresponds to the input level in dBm, with a 1 dB change in signal level giving rise to a 100 mV change in output level. Thus for a signal level of 0 dBm, the output level is 0 V, for +10 dBm the level is +1 V, and for -10 dBm the level is -1 V. For systems applications, a digital output may be specified as Option 01, "Parallel Data Output." Under this option, the instrument comes equipped with an isolated interface circuit. The interface outputs BCD formated data corresponding to the digits of the display. Electrical isolation between the digital output and the analog circuits within the unit assures that the measurement of low power levels will not be degraded by ground currents flowing between the system ground and the power meter's ground.

1.2 PERFORMANCE SPECIFICATIONS

Table 1-1 gives the performance specification for the Models 1036 and 1037. Table 1-2 gives the specifications for the Power Detectors used with the Models 1036 and 1037.

TABLE 1-1 SPECIFICATIONS

POWER RANGE	
Model 1036:	One range extends from -40 dBm to +10 dBm (100 nW to 10 mW).
Model 1037:	One range extends from -30 dBm to +20 dBm (1 uW to 100 mW).
ACCURACY	±0.02 dB for the upper 30 dB of the power range.
	±0.04 dB for the lower 20 dB of the power range.
NOISE	
Model 1036:	<0.4 dB peak to peak at -40 dBm.
Model 1037:	<0.4 dB peak to peak at -30 dBm.
	(Measured with the display filter in.)
CALIBRATOR	
Power output:	+10 dBm (10 mW), uncertainty of 0.06 dB (1.5%).
Impedance:	50 ohms, SWR of source <1.04.
Frequency:	30 MHz nominal
Stability:	0.001 dB/degree centigrade
	0.04 dB for a period of 3 months
DIGITAL READOUT	
Resolution:	0.01 dB, with four digits
Display rate:	12 readings/S nominal; up to 125/S if equipped with Option 01, Digital Output.
ANALOG OUTPUT (REAR PANEL)	
Coefficient:	100 mV/dB ±1 mV.
Level:	0 V ±10 mV output for 0 dBm input RF power.
Noise, Model 1036:	<0.1 dB peak to peak at -20 dBm.
Noise, Model 1037:	<0.1 dB peak to peak at -10 dBm.
Impedance:	<100 ohms.

(Continued)

Table 1-1 SPECIFICATIONS (Cont.)

CALIBRATION FACTOR CONTROL	
Range:	±1.0 dB
Precision:	Graduations each 0.1 dB
TEMPERATURE RANGE	15° C to 45° C
OPTION 01:	Isolated parallel digital output.
OPTION 02:	APC 7 connector replaces Type N connector on the Calibrator output.
OPTION 03:	SMA connector replaces Type N connector on the Calibrator output.
POWER REQUIREMENTS:	115/230 Vac ± 10%, 50-400 Hz. Approximately 20 VA.
PHYSICAL	
Size:	5.3" H x 7.8" W x 11.0" D
Weight:	7 lbs. (3.2 kg.)
Color:	Blue with contrasting light blue panel.
RACK ADAPTER:	Model 1006 with Model 1006-3 1/2 rack blank panel.

TABLE 1-2 DETECTOR SPECIFICATIONS

Part Number	Frequency Range	SWR (Max.)/Return Loss (Min.)				Maximum Power Input Peak or CW	Connector	Use With Model
		to 4 GHz	to 8 GHz	to 12.4 GHz	above 12.4 GHz			
11611	1 MHz-12.4 GHz	1.15/23 dB	1.22/20 dB	1.35/16.5 dB	- - - -	100 mW	Type N*	1036
12237	1 MHz-18 GHz	1.2/21 dB	1.35/16.5dB	1.5/14 dB	1.7/11.8 dB	50 mW	Type N*	1036
11939	1 MHz-18 GHz	1.15/23 dB	1.22/20 dB	1.35/16.5 dB	1.6/12.8 dB	100 mW	APC-7	1036
12236	1 MHz-18 GHz	1.2/21 dB	1.35/16.5dB	1.5/14 dB	1.7/11.8 dB	50 mW	APC-7	1036
12339	1 MHz-18 GHz	1.2/21 dB	1.35/16.5dB	1.5/14 dB	1.7/11.8 dB	50 mW	SMA	1036
11855	1 MHz-14 GHz	1.15/23 dB	1.22/20 dB	1.22/20 dB	1.5/14 dB	1 W	Type N*	1037

Frequency Correction Data: Maximum uncertainty of calibration points is 2% at 0 dBm (1 mW).
Power Linearity: 0.04 dB/10 dB when used with a PM Power Meter except P/N's 12236, 12237 and 12339 are 0.08 dB/10 dB on upper 10 dB.
Impedance 50 Ω
*Type N Stainless Steel, Precision Male

SECTION 2

INITIAL INSTRUCTIONS

2.1 RECEIVING INSPECTION

Unpack the instrument carefully and check for any obvious shipment damage. If damage is evident, file a claim against the carrier. The carrier will normally supply appropriate forms.

2.2 POWER REQUIREMENTS

Units are ordinarily connected at the factory for operation from 105 volts to 125 volts ac at 50 to 400 Hz. The unit may be adjusted for operation from 210 volts to 250 volts ac if so required. Conversion from one voltage to another may be made by changing the position of the rear panel VOLT switch. In either position, the switch exposes numbers indicating the correct operating line voltage. To change the position of the switch, insert a small screwdriver in the slot provided and push the switch in the desired direction.

2.3 CHASSIS GROUNDING

The instrument is supplied with a three-conductor NEMA type power cord. The instrument will be properly grounded if the plug is connected into a properly installed three-prong receptacle. If a three-prong to two-prong adapter is used, be sure that the pigtail lead of the adapter is grounded.

WARNING

FAILURE TO PROPERLY GROUND THE INSTRUMENT CAN ALLOW DANGEROUS VOLTAGES TO BUILD UP ON THE CHASSIS WHICH COULD BECOME DANGEROUS TO OPERATING PERSONNEL.

2.4 RETURNING THE INSTRUMENT

If it is necessary to return the instrument to Pacific Measurements, authorization must first be obtained from our Sales Department or local representative. Before packaging, the instrument should be wrapped in a protective material such as polyethylene to protect it from marring. If you do not have the original shipping container, wrap the instrument in a large quantity of protective padding material such as foam or hair flex and use a rugged cardboard or wooden container as a packing carton. Pack the instrument firmly so that it will not move around in the container. A letter containing all pertinent information should be included with the package unless you have already sent such a letter to our Sales Department.

2.5 ACCESSORIES

The following accessories are provided with each instrument:

Qty	Part No.	Description
1	10053	3 Conductor Power Cord
1	-----	Instruction Manual

2.6 CERTIFICATION

Pacific Measurements Incorporated certifies that this instrument was thoroughly tested and inspected and found to meet all its published specifications when it was shipped from the factory. Pacific Measurements Incorporated further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

2.7 WARRANTY AND ASSISTANCE

All Pacific Measurements products are warranted against defects in materials and workmanship. This warranty applies for one year from date of delivery, or in the case of certain major components listed in the instruction manual, for the specified period. Pacific Measurements Incorporated will repair or replace products which prove to be defective during the warranty period free of charge. No other warranty is expressed or implied. We are not liable for consequential damages.

For assistance contact your nearest Pacific Measurements franchised representative office or the factory in Palo Alto, California.

SECTION 3

OPERATION

3.1 FRONT PANEL CONTROLS

In addition to the power switch, the following controls are on the front panel.

a. OPERATING MODE PUSHBUTTONS. Three mechanically interlocked buttons select the normal operating mode or either of the two calibration modes. Depressing the dBm button causes the instrument to read the power incident upon its detector directly in dBm and the CALIBRATION FACTOR control described below is active. Depressing the dBm CAL button disables the CAL FACTOR control and turns on the calibrator oscillator. The detector can then be screwed onto the CALIBRATOR OUTPUT and the instrument's calibration checked. Depressing the ZERO button connects the instrument so that the display will read zero when the ZERO screwdriver control is properly set and no RF power is applied to the detector. The calibrator oscillator is off when ZERO is depressed.

b. DISPLAY FILTER SWITCH. When set to IN, this switch slows the response of the display. Useful when measuring at low levels or observing noisy signals, the display filter reduces the jitter in the least significant digit. When set to OUT, normal instantaneous response is restored.

c. CALIBRATION FACTOR CONTROL. This control adjusts the sensitivity of the instrument to compensate for the variation in detector sensitivity with frequency. A calibration chart is affixed to each detector; the CALIBRATION FACTOR control should be set to the value read from the chart at the frequency closest to the operating frequency. If the detector is used in conjunction with a directional coupler or attenuator of known calibration factor, this may be added (algebraically in dB) to the detector's calibration factor and the control set to the resultant value. The display will then read directly without need of further correction.

d. dBm CAL SCREWDRIVER ADJUSTMENT. This control is adjusted only when the dBm CAL pushbutton is depressed and the detector is screwed onto the CALIBRATOR OUTPUT connector. When this is done, the dBm CAL screwdriver adjustment is set so that the display reads 10.00 dBm. This adjustment will normally be required only if the instrument's ambient temperature has been changed by several degrees.

e. ZERO SCREWDRIVER ADJUSTMENT. This control is adjusted only when the ZERO pushbutton is depressed and all RF power is removed from the detector input. When this is done, the ZERO screwdriver adjustment is set so that the display reads 0.00. The last digit may wander a few numbers, but the adjustment will be correct if the polarity sign is alternating + and -.

3.2 REAR PANEL CONTROLS

a. OUTPUT GROUNDING SWITCH. This switch selects if the ANALOG OUTPUT BNC connector shell is to be tied to the instrument ground. When oscilloscopes or X-Y recorders used to monitor the ANALOG OUTPUT are fully isolated from ground, INT GROUNDING should be selected to provide a signal return path. When a device connected to the ANALOG OUTPUT has a ground connection external to its input connector (as is the case when its input connector is tied electrically to a chassis and a three prong grounding power plug is used) the switch should be set to EXT. This way, the BNC connector shell is isolated and there will be no ground currents flowing in the sensitive detector circuits.

b. LINE VOLTS SWITCH. This switch selects the line voltage from which the instrument will operate, either 115 or 230. The switch has an embossed plate attached adjacent to the screwdriver slot indicating the voltage to which it is set. The switch may be moved by using a small screwdriver to push it to one side or the other.

c. TRIGGER SWITCH (OPTION 01 ONLY). This switch selects trigger mode for the digital display on those instruments equipped with Option 01, Isolated Data Output. When set to INT SLOW, the display triggers at the normal 10 per second rate. When set to INT FAST, the display triggers at the fastest rate possible--about 200 per second. When set to EXT, the display will take a new reading only after the application of an external pulse. If your instrument is equipped with Option 01, additional information will be found on the option sheet in the front of the manual.

3.3 FRONT PANEL INDICATORS

a. DIGITAL DISPLAY. Four numeric indicator tubes and a polarity indicator display the measured power directly in dBm in the dBm mode. They also serve as indicators when calibrating or zeroing the instrument. The tubes are lit whenever the power switch is on, and no additional pilot light is provided.

b. OVER RANGE LIGHT. This indicator is illuminated whenever power in excess of the measurement range of the instrument is applied to the detector. In the case of the Model 1036 it comes on at approximately +13 dBm; for the Model 1037 it lights at approximately +23 dBm. During initial warm-up, it is normal for it to light if even a small amount of RF power is applied to the detector.

3.4 FRONT PANEL CONNECTORS

a. INPUT CONNECTOR. The detector is connected to the instrument with a four foot cable that is stored in the bottom of the instrument. To extend the detector from the instrument, turn the instrument upside down, raise the bail and remove the cable from the storage compartment. Grasp the knurled nut and remove the detector while guiding the cable through the holder. The input connector is a stainless steel precision Type N male connector or a Type APC 7 connector. Impedance is 50 ohms.

b. CALIBRATOR OUTPUT CONNECTOR. This connector supplies exactly 10 mW at approximately 30 MHz. Source impedance is 50 ohms. Power is available from this output only when the dBm CAL button is depressed.

3.5 REAR PANEL CONNECTORS.

In addition to the power connector the following connectors are on the rear panel.

a. ANALOG OUTPUT BNC CONNECTOR. This connector supplies a voltage equivalent to the reading on the digital display. For a display reading of 00.00 the output voltage will be zero volts. At other levels, the reading will correspond to that of the display with a coefficient of 100 mV/dB. When the input to the instrument is changing rapidly, as when monitoring the

output of a test system using a swept frequency source, the analog output will follow the signal at a much higher rate than will the display. The speed of response is sufficient to permit most swept frequency response curves to be observed on an oscilloscope at a flicker-free rate. Refer to Section 3.2a for instructions on the use of the GROUNDING switch.

b. DATA OUTPUT (OPTION 01) ONLY). If the instrument is equipped with Option 01 data is output and a read command is supplied through the DATA OUTPUT connector. See the option sheet in the front of the manual for further information.

3.6 OPERATING PROCEDURE.

CAUTION

Continuous or peak levels in excess of +20 dBm for the Model 1036 and in excess of +30 dBm for the Model 1037 can damage the point contact diode in the detector. Always take precautions to insure that the detector input will be well below this power level before connecting it to a source of RF power.

a. Connect the line cord. Be sure that it is properly grounded. The instrument is equipped with a three prong power connector; for the safety of operating personnel it is important that grounding pin be inserted into a proper plug. Failure to observe this precaution can allow the instrument's chassis to become electrically "hot" when connected to auxilliary equipment that is at an elevated potential.

b. Turn the POWER switch ON. Allow a fifteen minute warm-up if possible. In any case, with the INPUT detector connected to the CALIBRATOR OUTPUT and the dBm CAL button depressed, the reading must be allowed to stabilize.

c. With no power applied to the detector (as will be the case if the detector is connected to the CALIBRATOR), depress the ZERO button. If necessary, adjust the ZERO screwdriver control so that the display reads almost zero and the sign is alternating between + and -. Unless power measurements below -30 dBm are to be made, a small residual reading of less than ±0.10 may be left without the need for further adjustment.

d. Connect the detector INPUT to the CALIBRATOR OUTPUT and depress the dBm CAL button. Adjust the dBm CAL screwdriver adjustment so that the display reads +10.00 dBm.

e. To measure power, depress the dBm button. Note the frequency at which power is to be measured and consult the Frequency Correction Chart affixed to the detector. Set the CAL FACTOR control to agree with the value read from the chart at the frequency closest to the measurement frequency. If you are unsure of the approximate power of the source to be measured add enough attenuation in front of the detector to insure meeting the requirements of the caution notice above. After making a measurement with the attenuators in place you can determine how much (if any) attenuation you actually need. If the OVER RANGE light comes on when you are making a measurement you should immediately reduce the power level, as the reading no longer will be accurate nor will it be a reliable guide for indicating how close you are operating to the burn-out level of the detector.

If you are operating at low levels, you should periodically check the ZERO adjustment. This is particularly important for a period of one hour after turn-on. The CAL adjustment should not require checking unless the room temperature has changed by a few degrees, or you question a measurement. You will find that the calibrator is a particularly useful feature, as it gives a degree of confidence not otherwise possible.

3.6.1 USE OF THE ANALOG OUTPUT. The rear panel ANALOG OUTPUT provides a signal proportional to the RF signal level (in dB). See Section 3.5a for a description of output signal. When using a swept frequency signal source, the analog output can be used to drive the vertical axis of an oscilloscope or X-Y recorder and the sweep output from the generator used to drive the horizonal. If the vertical and horizontal inputs are truly differential and isolated from each other and ground, the rear panel grounding switch should be set to INT. Otherwise set it to EXT. The response speed of the instrument is sufficient to allow sweeping at a flicker-free rate. The use of X-Y recorders or oscilloscopes with large dc offset capability permits the use of dc coupling even when viewing fine grain variations in level at high sensitivities.

The analog signal can also be used to drive strip chart recorders and data scanners for continuous monitoring of RF power over extended periods of time. The low drift rate of the instrument recommends it for such application. For applications requiring digital information, a digital output is available as Option 01 at moderate cost.

SECTION 4
PERFORMANCE CHECKS

4.1 GENERAL

The purpose of this section is to provide enough information for the user of the Model 1036/1037 to verify that it is operating within its specifications. Detailed checking involves facilities normally found in standards laboratories. Unless you have well maintained RF power standards, attenuators, and return loss measuring equipment, you are urged not to attempt to verify the calibration of the instrument. Pacific Measurements maintains the necessary facilities to check the performance and perform calibrations as required; calibrations are performed in our plant for reasonable charges.

4.2 EQUIPMENT REQUIRED

a. A digital voltmeter with 1 mV minimum resolution.

b. A precision thermal voltage converter designed for use at the 1 volt rms level. If the converter is not matched to 50 ohms (200 ohms is a common impedance level), measure its resistance with a bridge and select a metal film resistor that will shunt it to 50 ohms ±0.5 ohm. Measure the combination with a bridge to see that it is indeed 50 ohms. Use caution when bridging the thermal converter so that the bridge power does not exceed its voltage rating.

c. A differential voltmeter with sufficient resolution to resolve 0.1% of the output of the thermal converter.

d. A precision dc supply capable of supplying 1.414 V, ±0.01%. A 50 ohm ±0.1% resistor must be connected in series with the supply.

e. A precision, calibrated step attenuator with 10 dB minimum steps. Accuracy better than 0.01 dB per 10 dB. Alternatively, a 30 MHz crystal controlled source of 1 W power output and a 30 MHz waveguide-beyond-cutoff attenuator with 0.01 dB accuracy per 10 dB.

f. A reflectometer setup covering the band from 1 to 14 GHz. Such setup to comprise directional couplers of 30 dB minimum directivity, sweep signal sources covering the range of frequencies, and power monitoring devices such as the Pacific Measurements Model 1009 or another Model 1036/1037.

4.3 PERFORMANCE CHECKS

4.3.1. POWER LINEARITY CHECK. The following procedure checks the linearity of the detector-instrument combination at 30 MHz.

a. Connect the precision step attenuator between the calibrator output and the detector input. If the attenuator steps are not precisely 10 dB, but calibration data for the attenuator is known, you must make an appropriate correction to the following table. Make the ZERO adjustment (see paragraph 3.1e) prior to making the measurements in the following table. The measurements are made in the dBm CAL mode and the reading set using the CAL adjustment.

Attenuator Setting	1036 Reading
0 dB	+10.00±0.00 dBm (set)
10 dB	0.00±0.06 dBm
20 dB	-10.00±0.10 dBm
30 dB	-20.00±0.14 dBm
40 dB	-30.00±0.22 dBm
50 dB	-40.00±0.26 dBm

Attenuator Setting	1037 Reading
0 dB	+10.00±0.00 dBm (set)
10 dB	0.00±0.06 dBm
20 dB	-10.00±0.10 dBm
30 dB	-20.00±0.18 dBm
40 dB	-30.00±0.22 dBm

NOTE: Noise may add an additional error of 0.40 dB at -40 dBm for the Model 1036 and at -30 dBm for the Model 1037.

If it is desired to check the range of the Model 1037 to +20 dBm a source of at least +20 dBm power capability will be required. If the instrument is set to agree at +10 dBm, and 10 dB of attenuation is removed, it should read +20.00±0.06 dB. If the waveguide-beyond-cutoff attenuator is used as an alternative to the calibrator-attenuator technique, be sure that you use a 30 MHz crystal controlled source with good amplitude stability and freedom from harmonics. The table of values in this section applies regardless of the technique used to vary the power.

b. Check the analog output to see that it agrees with the display within the limits of the specification. Connect the DVM to the ANALOG OUTPUT connector in the rear of the instrument and check to see that the readings agree with those given in the table below.

Display Reading	Output Voltage
+10.00	+1.000 ±20 mV
0.00	0.000 ±10 mV
-10.00	-1.000 ±20 mV
-20.00	-2.000 ±30 mV
-30.00	-3.000 ±40 mV

4.3.2. INPUT REFECTION COEFFICIENT CHECK. To ascertain that the input refection coefficient specifications are met follow the following procedure in each octave band from 1 GHz to 14 GHz.

a. Connect a high directivity directional coupler to the output of the leveled sweep signal source so that it monitors reflected power. Connect the power monitor to the coupled arm of the coupler. Calibrate the set-up using a short or fixed known mismatch.

b. Before you connect the detector to the output of the directional coupler, be sure that the power from the signal source does not exceed the maximum specified for the detector. If you are in doubt, first connect a fixed pad with enough attenuation that you are sure that it will not exceed the maximum rating of the detector and measure the power. If necessary, reduce the power from the source by either turning it down or adding attenuation. Now connect the detector and see that the power into the power monitor on the coupled arm is reduced from that measured in Step a by the amount of the return loss specified in Table 1-2. The test may be done on a swept basis by calibrating an oscilloscope to read return loss over

the entire band. Cf. Pacific Measurements Model 1009 Instruction Manual, or Pacific Measurements Technical Note No. 1; Power and Signal Level Measurements in Microwave Systems.

4.3.3 CALIBRATOR OUTPUT LEVEL CHECK.

a. Set the precision supply to 1.414 V. Connect the thermal converter to the supply through the 50 ohm resistor. (It is helpful to build up a little fixture including a 50 ohm resistor and a Type N connector so that the thermal converter is easily connected and disconnected from the source.) Connect the differential voltmeter to the output from the thermal converter and read its voltage. This must be done with all of the precision available, as the voltage will be only a few millivolts. Reverse the polarity and note the new voltage reading. Record the average. Now press the dBm CAL button and connect the thermal converter to the CALIBRATOR OUTPUT. Note the reading from the differential voltmeter. If it differs from the reading obtained from the precision power supply, reconnect the thermal converter to the power supply and set the supply so that the voltage from the converter is the same as it was when on the calibrator. Note the reading, reverse the polarity and again set the supply so that the thermal converter's output matches what it was when on the calibrator. Average the two readings. When this is done the supply voltage should be between 1.425 and 1.403 volts. It may be necessary to repeat the above procedure several times until consistent results are obtained. This completes the performance checks. If the instrument does not meet any of the above performance criteria, it may be calibrated in accordance with Section 6.1, Maintenance.

SECTION 5

CIRCUIT DESCRIPTION

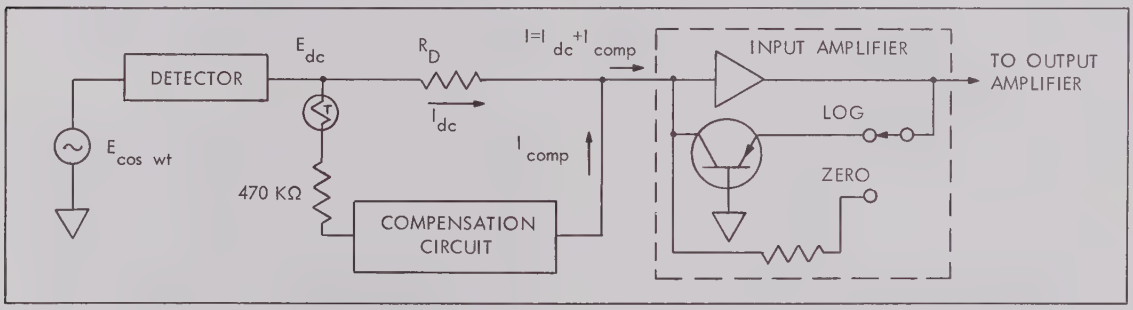
5.1 GENERAL DESCRIPTION.

Simplified circuit diagrams of the instrument are shown in Figures 5-1 and 5-2. Referring to Figure 5-1, the detector output, E_{dc}, is fed through R_D to the current summing junction of the input amplifier. E_{dc} is also applied to the compensation circuitry through the thermistor and a 470 K ohm resistor. The compensation circuit output current is fed into the current summing junction of the input amplifier such that the total current into the input amplifier is $I_{dc} + I_{comp}$. Since the Model 1036/1037 is logarithmic, a transistor is used in the feedback loop. Thus the output voltage of this amplifier is equal to the log of the input current. In the linear (or zeroing) mode, a resistive divider is placed across the input amplifier. This divider is represented schematically by a resistor in Figure 5-1.

Figure 5-2 shows the output amplifier, digital display driver, and a simplified schematic of the output switching. The first stage of the output amplifier is used to amplify the logarithmic output of the input amplifier. All logarithmic offsets are summed by the second stage and applied to the output circuitry. Note the output amplifier is used only in the logarithmic mode. In the linear zeroing mode, the output of the input amplifier is applied directly to the digital display.

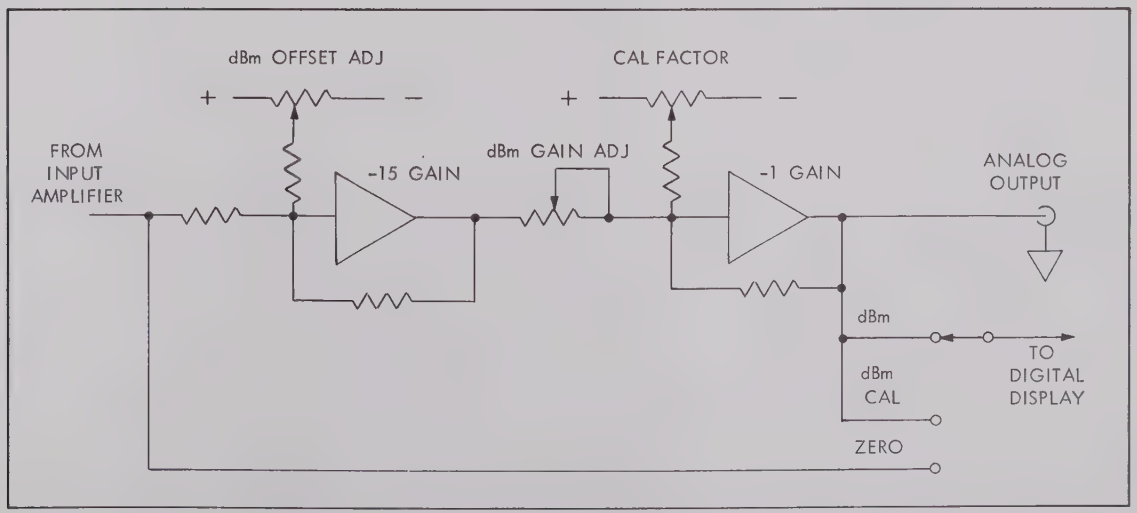
5.2 DETECTOR COMPENSATION

Point contact diode detectors have been used to measure RF power for quite some time, but until recently their useful measurement range has been restricted to the square law region where output voltage is approximately proportional to input power. In reasonably fast-response applications, the lower end of the measurements range is limited by noise. The upper end of the usual measurement range occurs where the detector output response begins to depart significantly from square law. In the instrument, a compensation signal is generated such that, when it is added to the detector output, the resulting sum is proportional to RF power input to levels up to the reverse breakdown voltage of the diode. This is possible because of the predictable behavior of the diodes used in detectors.



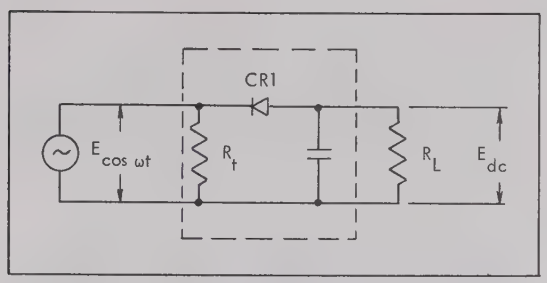
COMPENSATION AND INPUT AMPLIFIER

FIGURE 5-1



OUTPUT AMPLIFIER

FIGURE 5-2



DETECTOR

FIGURE 5-3

Figure 5-3 shows the schematic of a typical detector. The diode, CR1, merely rectifies the RF voltage across the terminating resistor, R_t. In the instrument R_t is a 50Ω termination and CR1 is a microwave point contact diode. The relationship between the peak RF input voltage, E, and the detectors dc output, E_{dc}, is described by the following equation:

$$\left[1 + \left(\frac{R_V}{R_L}\right) B E_{dc}\right] e^{B E_{dc}} = I_o (B E) \qquad \text{Eq. 5-1}$$

where: R_V is the diode low level video resistance

R_L is the detector load resistance

B is almost equal to Q/kT

I_o is the zero order modified Bessel function of the first kind.

At low levels, Equation 5-1 may be approximated by the expression:

$$E_{dc} = \frac{B E^2}{4 (1 + k)} \qquad \text{Eq. 5-2}$$

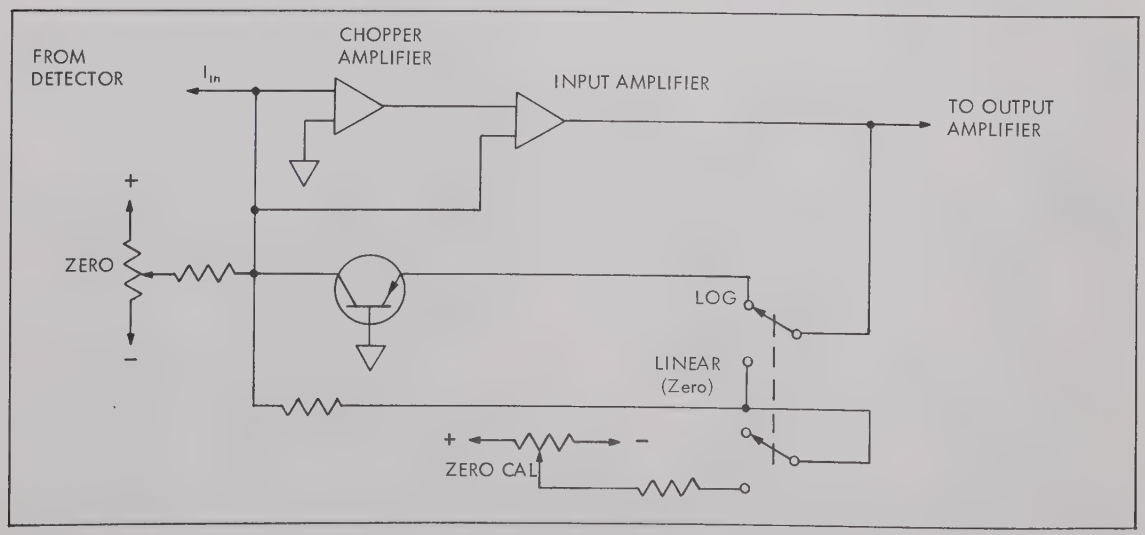
where: k is R_V/R_L.

The square law relationship shown in Equation 5-2 shows that the detector dc output is proportional to the square of RF input voltage which in turn is proportional to the RF input power. Equation 5-2 describes the desired detector response while Equation 5-1 describes the actual detector response. The compensation circuitry in the instrument generates a signal equal to the difference between the detector outputs described by Equation 5-2 and Equation 5-1. The resulting compensation signal is added to the detector output described in Equation 5-1 and the resultant sum of signals provides a response described in Equation 5-2. This compensation is temperature sensitive because the detector diode parameters are temperature dependent. The temperature dependence of the diode parameters is predictable, and a thermistor network may be used to maintain accurate compensation over a temperature range of 18°C to 45°C. The thermistor network maintains the compensation accurate only for relative, rather than absolute, power measurements over the temperature range. By proper design, this temperature dependence has been minimized. Furthermore, the instrument is equipped with a calibrated power reference so that accurate absolute power measurements are easily made at any temperature between 18°C and 45°C.

5.3 INPUT AMPLIFIER

A simplified circuit diagram of the input amplifier is shown in Figure 5-4. This amplifier consists of a high gain, chopper stabilized, operational amplifier capable of being operated in logarithmic or linear mode by selection of its feedback network.

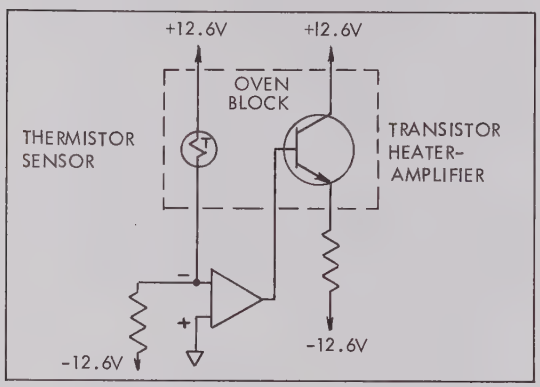
To operate the input amplifier in the logarithmic mode, a transistor is used in the feedback loop around the operational amplifier. Referring to Figure 5-4, I_{in} is proportional to $e^{qE/kT}$, since the operational amplifier has very high gain. Thus, E_o is proportional to log I_{in}. This logarithmic relationship between I_{in} and E_o holds over many decades of current because parasitic collector currents in the logging transistor are eliminated by operating its collector-base junction at zero volts. When operated in the logarithmic mode, the output level of this amplifier is approximately 6.7 mV/dB at 60°C and is a function of the temperature of the logging transistor. To maintain the logarithmic coefficient independent of ambient temperature, the logging transistor is mounted in a temperature controlled oven and held at 60°C. A power



INPUT AMPLIFIER

FIGURE 5-4

transistor serves to heat the oven and a thermistor mounted in the oven senses temperature, as shown in Figure 5-5. A one-stage amplifier is connected between the thermistor and the transistor heater amplifier. When the oven is at its correct temperature, the driver amplifier input is very near zero volts and the transistor heater amplifier generates just enough heat to maintain the oven at its proper temperature.



OVEN CONTROLLER

FIGURE 5-5

The chopper-stabilized operational amplifier has a high gain and is essentially free from dc drift. The action of the chopper amplifier is to hold the input summing junction of the operational amplifier at zero volts.

5.4 COMPUTER AMPLIFIER

Figure 5-6 is a simplified circuit diagram of the computer amplifier. Input is from the detector. The first stage logs the detector output and adjusts the level at which compensation becomes effective. Second stage output feeds an anti-log transistor whose collector delivers the compensation current to the input amplifier summing junction.

E_{dc} comes to the logging stage of the computer amplifier through a thermistor and a 470 K Ω resistor. The thermistor changes the correction signal such that level compensation is independent of temperature from 18°C to 45°C. The computer amplifier logs E_{dc} in precisely the same manner as it is logged in the input amplifier. Because of its temperature sensitivity, the logging transistor in the computer amplifier is also placed in the oven to keep the logging sensitivity of this amplifier independent of temperature. Since the correction signal does not become significant until detected RF power levels are above -30 dBm, the computer logging amplifier need not be as stable as the input logging amplifier. Consequently, this amplifier is not chopper stabilized. The X1.9 amplifier drives the anti-logging transistor, which sets the compensation for the detector by adding a signal to the input amplifier. As in the case of the logging transistor, the anti-logging transistor is temperature sensitive and is also placed in the temperature controlled oven.

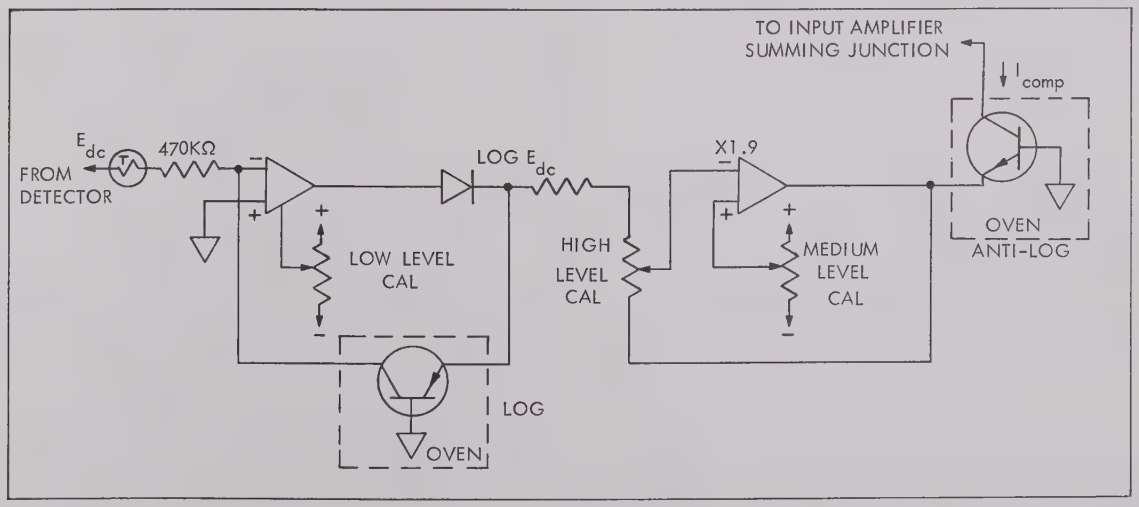
5.5 OUTPUT AMPLIFIER

A simplified circuit diagram of the output amplifier is shown in Figure 5-2. There are two inverting amplifiers connected in tandem so that the output signal has the same polarity as the input. The first amplifier has a gain of -15, raising the signal level from 6.7 mV/dB to -100 mV/dB. An offset adjustment corrects for variations in log transistor parameters, making the output 0 V for 0 dBm input level. The second amplifier has a gain of -1 nominal and can be trimmed with the dBm GAIN ADJ., so that its output is exactly 100 mV/dB. The output from the CAL FACTOR front panel control is summed in at the second amplifier. The DVM displays the output of the amplifier pair in the dBm and dBm CAL modes and the input amplifier's output in the ZERO mode. In the dBm CAL mode power is removed from the CAL FACTOR control, as the Calibration Factor is defined as unity at the calibrator frequency.

5.6 CALIBRATOR

The calibrator consists of a 30 MHz oscillator, 30 MHz low pass filter and a 4 dB, 50 Ω attenuator. CALIBRATOR OUTPUT is from a front panel Type N connector.

The 30 MHz calibrator oscillator operates within a very stable amplitude regulating loop so that its output level is only a function of a reference voltage. The calibrator output level is set by adjusting the reference voltage divider. The oscillator output feeds the low pass filter from a 50 Ω resistor tapped into the 30 MHz resonant circuit.



COMPUTER AMPLIFIER
FIGURE 5-6

5.7 DIGITAL DISPLAY

The digital display performs the function of converting a dc voltage into a row of digits to be read by the instrument's user. Basically, it is an analog to digital converter whose output drives display tubes. In the Pacific Measurements display, the tubes are driven sequentially (strobed) at a rate imperceptible to the human eye, so that some of the circuits can be time-shared. This results in considerable simplification , as the circuits would otherwise be duplicated.

Digit conversion takes place in a circuit comprising a digital to analog converter (DAC), an amplifier with a gain of precisely 10, and a comparator to control the DAC. The DAC is driven from a counter whose gate is controlled by the comparator. The DAC thus generates a staircase voltage as the counter increments; the terminal value of the staircase is determined by the point at which the comparator closes the gate to the counter. The nature of the information fed to the comparator will be described below.

The signal to be converted feeds the positive input of the X10 amplifier. The DAC drives the negative input, so that the output of the amplifier is 10 times the difference of the inputs. Each step of the staircase from the DAC is 0.5 V, corresponding to 5.0 V at the amplifier's output. The comparator is set so that it will permit the counter to increment if the output of the amplifier is greater than 5.0 V. That is, it counts until the remainder is less than one digit, completing the conversion process for that digit.

The output of the amplifier after conversion of the first digit is actually ten times the remainder after subtracting the first digit. This remainder, then, becomes the input to the conversion circuit for the second digit, and that remainder becomes the input to the conversion circuit for the third, and so on. In order to move the dc voltage from the amplifier's output to its input, the voltage is stored on a capacitor and the capacitor is switched from the output to the input. Another capacitor is connected to the output for use with the next digit.

Immediately after each digit's conversion takes place, the output of the counter is fed to a display decoder-driver which feeds all of the display tubes in parallel. The tube corresponding to the digit just converted has a positive pulse applied to its anode, causing it to light and display that digit.

In many cases it is required that the display hold its reading for a time until it is commanded to up-date its reading. Thus, some sort of memory is required. The Pacific Measurements display uses a capacitor to hold an analog voltage corresponding to each digit. The capacitors corresponding to each digit are polled sequentially and read by the conversion circuit and their value displayed.

In operation, the output of the DAC is fed to a separate capacitor corresponding to each digit, immediately after conversion. When it comes time to read the value of the voltage stored on the capacitor it is connected to the input to the conversion circuit and its value measured and displayed. After conversion, the capacitor is once again connected to the output of the DAC and its voltage refreshed. During periods when the display is in the store mode, this process of measurement and restoration takes place approximately 600 times per second, well above the rate that the eye is capable of perceiving.

The various switching functions are carried out by a series of analog FET gates. These gates have almost ideal characteristics, such as no offset, low "on" resistance, and rapid actuating speed. The driving circuits for these gates have provision for decoding the signals sent to them, eliminating the need for separate logic circuits to perform this function.

Since the display can not convert signals of negative polarity, a precision "absolute value" circuit supplies it with unipolar signals. This circuit makes use of diodes to switch from an inverting to a non-inverting circuit. The diodes are enclosed within a feedback loop, so that the circuit will not be sensitive to their characteristics. The input impedance of this circuit is a constant 5 KΩ, independent of the polarity of the input.

SECTION 6

MAINTENANCE

6.1 PERIODIC MAINTENANCE

The following maintenance should be performed once a year unless the instrument is operated in an extremely dusty or chemically contaminated environment or is subject to severe abuse. In such cases, more frequent service is indicated.

a. Blow out all accumulated dust with forced air under moderate pressure.

b. Inspect the instrument for loose wires and damaged components. Check to see that all wire lead connectors are properly seated on their PC board pins.

c. Make a performance check in accordance with the procedure in Section 4, "Performance Checks." If the results of the performance checks are within specifications, no further service is necessary. If not, perform the appropriate calibration procedures described in Section 6.3.

6.2 INTERNAL ADJUSTMENTS AND TEST POINTS.

The following is a list of adjustments and test points supplied for ready reference. Do not attempt to make any adjustments before you have carefully read the material in Section 6.3 below.

6.2.1 DESCRIPTION OF ADJUSTMENTS

The function of each adjustment is described below:

a. A1R10 Zero. Used to set the display to read zero for zero volts input.

b. A1R26 Comparator adjustment. Used to set the display to change its reading from 79.99 to 80.00 for 3.9997V input.

c. A1R34 D to A converter zero. Used to set the summing junction of the DAC (TP12) to zero volts ±0.1 mV.

d. A1R78 -Full Scale Adjustment. Used to cause the display to read the same number for both polarities of input for 4.002 V input.

e. A1R80 -Balance. Used to set the voltage at TP14 to 10.0 mV ±0.1 mV for -5.00 mV input.

f. A1R86 +Balance. Used to set the voltage at TP14 to 10.0 mV ±0.1 mV for +5.00 mV input.

g. A1R100 +Full Scale Adjustment. Used to set the display to read +88.84 for +4.442V input.

h. A2R9 LOW LEVEL CAL. Used to set the input circuit for proper tracking at -10 dBm input level.

i. A2R12 MEDIUM LEVEL CAL. Used to set the input circuit for proper tracking at 0 dBm input level.

j. A2R17 HIGH LEVEL dBm CAL. Used to set the input circuit for proper tracking at +10 dBm.

k. A2R63 ZERO CAL. Used to set the display to read zero after the instrument has been properly zeroed by other means.

l. A2R72 INPUT ZERO. Used to set the voltage at TP24 to zero volts.

m. A2R88 DBM OFFSET. Used to center the range of the DBM CAL screwdriver adjustment.

n. A2R98 DBM GAIN. Used to set the signal level to the digital display so that one decade change in RF power causes the display to read 10 dB.

o. A2R104 CAL FACTOR ADJ. Used to cause the front panel CALIBRATION FACTOR control to track the digital display. Thus, if the CALIBRATION FACTOR control is set to +.4, the display should increment by .4 dB.

p. A2R114 10 mW CALIBRATOR ADJ. Used to set the calibrator output to 10 mW.

q. A2R144 -12.6 ADJ. Used to set the -12.6 V supply to -12.6 V.

6.2.2 TEST POINTS

a. A1J1(TP 11) Times 10 amplifier output. Used to check the operation of the digit conversion circuit.

b. A1J2(TP 12) DAC summing junction. Measure between +TP12 and -TP13.

c. A1J3(TP 13) Analog ground.

d. A1J4(TP 14) Absolute value circuit output. Measure between TP 14 and TP 13 ground.

e. A1J5(TP 15) TRIGGER. Used to trigger a test oscilloscope when trouble-shooting the display.

f. A2J1(TP 21) COMPENSATION AMPLIFIER MONITOR. Measure between +TP 21 and -TP 23. Make the initial adjustment of A2R9 so that the polarity of the reading changes as the input power goes through -27 dBm.

g. A2J2(TP 22) X2 AMPLIFIER MONITOR. Measure between TP 22 and TP 23. Monitors X2 amplifier for proper operation.

h. A2J3(TP 23) ANALOG SIGNAL GROUND.

i. A2J4(TP 24) INPUT AMPLIFIER SUMMING JUNCTION. Measure between TP 24 and TP 23. Set A2R72 to obtain zero volts ± 10 μ V.

j. A2J5(TP 25) LOG TRANSISTOR EMITTER. Measure between TP 25 and TP 23. Monitors output of the log amplifier for proper operation. (6.7 mV/dB)

k. A2J6(TP 26) CHOPPER AMPLIFIER OUTPUT. Measure between TP 26 and TP 23. Monitors the output of the chopper amplifier for proper operation.

l. A2J7(TP 27) OVEN CURRENT. Measure between +TP 27 and -TP 28. After initial warm-up, the voltage should be between 0.5 and 0.8 volts.

m. A2J8(TP 28) -12.6 VOLT SUPPLY. Measure between TP 28 and TP 23. The dc voltage should be -12.6 V ± 10 mV.

6.3 CALIBRATION

6.3.1 EQUIPMENT REQUIRED FOR CALIBRATION

a. DC voltmeter that can measure 12.6 volts with 1 mV resolution and 0.01% accuracy. A differential dc voltmeter is recommended.

b. DC source that can be set to 0.1% for voltages between 10 volts and 100 μ V. The ripple and noise must be at least 40 dB below the dc output. A dc calibration source and an external 20 dB pad is recommended.

c. A 1 MHz oscilloscope having a vertical sensitivity of at least 10 mV/division.

d. A set of attenuators calibrated at 30 MHz to ±0.01 dB. Two 10 dB and two 20 dB. A 30 MHz precision waveguide beyond cut-off attenuator is recommended.

d. A stable 50 Ω 30 MHz source capable of supplying at least 10 mW into 50 Ω with harmonics and spurious down at least 50 dB. If a precision 30 MHz waveguide beyond cut-off attenuator is used, the 30 MHz source should have a 1 W capability into 50 Ω.

f. A digital voltmeter that can measure 10 volts with 10 mV resolution and 0.05% accuracy.

g. An ac thermal transfer standard that has a traceable accuracy of at least 0.1% at 30 MHz at 1 volt and 50 Ω input resistance. A 200 Ω unit may be used if it input is shunted so that it is 50 Ω ±1%. If the transfer standard does not have a Type N connector, an adapter is required.

6.3.2 CALIBRATION PROCEDURE

The Model 1036/1037 employs solid state components exclusively. These are extremely reliable and generate little heat. Consequently, there is little drift due to component aging, and adjustments to the instrument are rarely required. We therefore strongly recommend that if measurements indicate that an adjustment is set within the stated range, that you do not attempt to put it "right on." It is often the case that variations in the equipment used to test the instrument account for small differences in measured values. Other adjustments dependent upon a given adjustment will be affected if it is reset. In short, BE ABSOLUTELY SURE THAT AN ADJUSTMENT IS REALLY REQUIRED BEFORE MAKING IT.

If a component is replaced, depending upon where in the circuit it is located, only certain of the calibration steps need be performed. The following list will help you to avoid needless procedures.

CIRCUIT	ADJUSTMENTS AND CHECKS Refer to Section 6.3.2.2
-12.6 VDC Supply	Step a only
+12.6 VDC Supply	Step a only
+5.0 VDC Supply	None required
+180 VDC Supply	None required
Oven Control and Heater	Steps b through j
Input Amplifier Log Circuit	Steps c, d, f and j
Computer Amplifier Log Circuit	Steps e, f, g and h
Output Amplifier	Step d only
At -40 dBm Does Not Read -40 But Higher Levels Are Right	Step h only
After Replacement of a Damaged Diode in Power Detector	Steps c, e, f, g, h and i
Calibrator Circuit	Step k only

6.3.2.1 DIGITAL DISPLAY

The following steps must be performed in the exact order indicated. Read the complete procedure through before beginning, then start with step a.

a. Disconnect the push-on connector from pin 29. Set the supply to zero volts. Connect the high side of the precision supply to pin 29, and the low side to pin 32. Connect the dc voltmeter to TP14 and Ground, TP13. Set the supply to +5.00 mV. Adjust A1R86 to obtain a reading of + 10.00 mV ±0.1 mV.

b. Set the supply to be -5.00 mV. Adjust A1R80 to obtain a reading of + 10.00 mV ±0.1 mV. Disconnect the voltmeter.

c. Set the supply to +4.002 V. Note the reading of the display. Apply -4.002 V. Adjust A1R78 so that the reading agrees with the previous reading.

d. Connect the voltmeter to TP12 and ground, TP13. Adjust A1R34 to obtain 0.00 mV +0.1 mV. Disconnect the voltmeter.

e. Set the supply for+3.9997V. Adjust A1R26 to cause the display to flicker back and forth between +7999 and +8000. This completes the calibration procedure for the display. Remove the supply and reconnect the wire to pin 29.

6.3.2.2 POWER MEASUREMENT CIRCUITS

The power levels used to test the Model 1037 differ from the levels used for the Model 1036 by 10 dB. The first level shown refers to the Model 1036; the level shown in parentheses is for the Model 1037. Before attempting to calibrate these circuits you should read the entire procedure through once, then perform the steps in the order indicated.

a. Connect the voltmeter with at least 1 mV resolution between TP28 and TP23, the negative probe to TP28 and the positive probe to TP23. Turn on the instrument, and after a five minute warmup, adjust A2R144 -12.6 V ADJUST until the voltmeter reads 12.600 V ±10 mV.

b. Connect the voltmeter between TP27 and TP28, the negative probe to TP28 and the positive probe to TP27. Turn on the instrument. At first the voltage should be around 2.5 volts and after one or two minutes the voltage should drop to about 0.5 volts and then after about five minutes should settle to a steady state voltage of about 0.6 V. Any steady state value between 0.5 V and 0.8 V is satisfactory.

c. Connect the power detector to an RF source of -30 dBm and press the dBm 50 Ω button. Connect a sensitive voltmeter with at least 10 μ V resolution between TP24 and TP23. Connect the positive probe to either test point and the negative probe to the other; then adjust A2R72 INPUT ZERO so the voltmeter reads 0 V ±10 μV.

d. Connect a precision dc source between TP24 and TP23. Connect the negative side to TP24 and the positive side

to TP23. Connect a voltmeter between TP25 and TP23, the positive probe to TP25 and the negative probe to TP23. Press the dBm button, set the power supply to 1 mV and measure voltage at TP25,

then set the power supply to 10 mV and measure the voltage at TP25, then set the power supply to 100 mV, and measure the voltage at TP25. For the change in the input voltage of 1 mV to 10 mV the voltage change at TP25 should be 67 mV ±5 mV. The change in the voltage at TP25 for the other changes in the input voltage should be within ±1 mV of the change for 1 mV to 10 mV, if not, repeat step c. Now connect the negative probe of the voltmeter to Pin 6 and the positive probe of the voltmeter to TP23. Set the power supply voltage to 1 mV and measure the output. Change the power supply voltage to 100 mV and again measure the output voltage. Now adjust A2R98 dBm GAIN until the change in the output is 2.00 V for the change of 1 mV to 100 mV in the input. After this adjustment is made, then change the input voltage from 1 mV to 10 mV and 10 mV to 100 mV and 100 mV to 1 V. Checking to make sure that the change in the output for each change in the input is 1.000 V ±2 mV. Readjust A2R98, dBm GAIN to achieve these results. (In order to obtain these results for the change of 1 mV to 100 mV, the dc ripple and noise ratio of the supply should be at least 40 dB.)

e. Connect the power detector to an RF source. With the RF off, press the ZERO button and zero the instrument. Then press the dBm button and set the RF input to -30 dBm (-20 dBm). Connect a voltmeter between TP21 and TP23. The polarity will change at the critical point in the adjustment, so the voltmeter can be connected in either polarity. Use the 1 volt full-scale range. Adjust A2R9, LOW LEVEL CAL, so that the voltage at TP21 just goes negative. Now, when the input power is increased by 3 or 4 dB, the voltage at TP21 should go positive.

f. Set the RF input power to -30 dBm (-20 dBm) and set the front panel dBm CAL adjust to center by adjusting for 0 volts at A2-7. Adjust A2R88, dBm OFFSET so that the display reads -30 (-20).

g. Set the RF input power to 0 dBm (+10 dBm) and adjust A2R12, MEDIUM LEVEL CAL, until the display reads 0 (+10). Then set the RF input power to +10 dBm (+20 dBm) and note the reading on the display. If it is greater than +10 (+20), adjust A2R17, HIGH LEVEL CAL, until the reading is less than +10 (+20) by about as much as it was greater before. If it is less, adjust A2R17 until the reading is as much greater than it had been less. Now reset the RF power to 0 dBm (+10 dBm) and readjust A2R12 until the display reads 0 (+10). This procedure should be repeated until a correct reading at both levels is obtained.

h. Set the RF input power to -40 dBm (-30 dBm) and adjust the front panel ZERO control so the display reads -40 (-30). Now set the RF power to -30 dBm (-20 dBm) and check that the reading is -30 (-20). If it is not, set the front panel dBm CAL adjustment so the reading is correct and then check and reset the -40 dBm (-30 dBm) reading using the front panel ZERO control, if necessary. Turn off the RF power, press the ZERO button and adjust A2R63 ZERO CAL, until the display reads 0 and the polarity is going between plus and minus.

i. To obtain proper tracking, repeat steps e thru h until no adjustments are required.

j. Set the RF power to +10 dBm and set the front panel CAL FACTOR control to 0. Press the dBm button and set the dBm CAL control so that the display reads +10.00. Now move the CALIBRATION FACTOR control to +1 dB. Adjust A2R104, CAL FACTOR ADJ, so that the display reads +11.00 . Move the CALIBRATION FACTOR control to 0 and - 1 dB. Readjust A2R104 to equalize any error.

k. Set the precision power supply to 1.414 V. Connect a precision 50 ohm 0.1% resistor from the output of the supply to the center conductor of a Type N connector. Connect the outer shell of the Type N connector to the other side of the supply. Now connect the thermal transfer standard to the Type N connector. Read its dc output to a precision of 0.1%. Reverse the polarity of the supply and repeat the reading. Record the average of the two dc output voltages from the transfer standard. Press the dBm CAL button, screw the transfer standard to the CALIBRATOR OUTPUT and adjust A2R114 so that the transfer standard has the same output as the average when connected to the supply. Reconnect the transfer standard to the supply through the 50 ohm resistor and check to see that the same output is obtained. This last step is important, as transfer standards do drift with changes in ambient temperature. If there is a significant difference in the readings before and after the calibrator measurement, repeat the procedure. This completes the calibration procedure.

6.4 TROUBLE SHOOTING

The process of trouble shooting is really one of successively isolating the cause of the trouble to smaller and smaller parts of the circuit. A trouble-shooting chart, Table 6-1 will help you in gross way; the circuit description, Section 5 should help with the detailed analysis of troubles within each circuit. In addition, the following general procedure should be followed.

a. Check to be sure that primary power is getting to the instrument. Normally the display lights if power is applied. A faulty power cord or line fuse commonly are the cause of trouble if the display does not light.

b. If there is power to the instrument but the display is incorrect or absent, check the rear panel ANALOG OUTPUT for proper operation. If operation is normal, the digital display is suspect; see j below. If operation is abnormal first check the point contact diode input, found on A2 pin 18. With +10 dBm applied to the detector (connect the detector to the CALIBRATOR OUTPUT and press the dBm CAL button) there should be approximately 0.5 V dc at pin 18 for the Model 1036; 0.15 V for the Model 1037. With no power applied the voltage should drop to 0. Be sure that the calibrator is working; a quick check can be made with an oscilloscope with 50 MHz bandwidth. The peak-to-peak voltage at the CALIBRATOR OUTPUT should be approximately 4 V open circuit. If a gross error is found, proceed to step c, then directly to i. If not proceed to c and continue.

TABLE 6-1 TROUBLE SHOOTING

INDICATION	CHECK	SEE SECTION
NO DIGITAL DISPLAY	1. Power cord. 2. Fuse, F1. Remove bottom cover. 3. Digital display.	--- 6.4j
DISPLAY WRONG BUT ANALOG OUTPUT O.K.	1. Digital display. 2. Trigger selector switch if Option 1 installed.	6.4j 3.2c
OUT OF CALIBRATION AT ALL LEVELS	1. Detector. 2. Perform calibration. 3. Oven.	6.4b 6.3.2.2 6.4d
OUT OF CALIBRATION AT HIGH LEVELS ONLY	1. Computer camplifier.	6.4f
EXCESSIVE LINE FREQUENCY SIGNAL ON OUTPUT	1. Grounding of associated test equipment.	3.6.1
OUT OF CALIBRATION AT LOW LEVELS ONLY	1. ZERO control. 2. Chopper amplifier.	3.1e 6.4e

c. Check the operation of the power supplies. Refer to schematic 11249. Measure from A2 pins 20, 21, and 32 to ground, TP 23. Voltages should be +12.6, -12.6, and +5.0 V dc. Ripple should be less than 2 mV. If these voltages are present, proceed to d. If these voltages are not present or are low, check each supply for an overload. This is done by removing jumpers 47-48, 45-46, and the leads from 32 and 33. If trouble is in the supply, first get the - supply operating, as the +12.6 supply is dependent upon it. The +5.0 V supply is independent of the others. If oscillations are present, check C68, C70 or C72.

d. Turn the power off and allow the instrument to stand for 5 to 10 minutes. Screw the detector to the calibrator and press the dBm CAL button. Now turn the power on and observe the display. The reading should start out very much above +10 dBm and settle out to the correct reading after a few minutes. If it does not change at all, or overshoots, ending up well below +10, check the oven as described in Section 6.3.2.2b. If operation is normal, proceed to e. If operation is not as there described, check Q33; initially the collector voltage should be about -5, dropping to -11.3 after warmup. If it is not open or shorted, check Q34.

e. Check the operation of the input amplifier by performing the procedure indicated in Section 6.3.2.2d. If operation is normal at low levels proceed to f. If the operation is normal at all levels, proceed to step g. If not, first check the operation of the chopper amplifier, as the input amplifier depends upon it for proper operation. Connect a dc voltmeter with at least 1 mV full-scale sensitivity between TP24 and TP23; by adjusting A2R72 it should be possible to bring the reading to zero. If not, connect an oscilloscope probe to TP26; the ground lead should go to TP23. Compare the waveform obtained thereby with the one shown in Figure 6-1. Short either end of A2R67 to ground and look again--the waveform should change briefly, then settle down to its previous appearance. In any case, with A2R67 shorted the waveform should appear normal; if not, trouble in the chopper amplifier is indicated. First, check the square wave drive signals applied to the two input FETs, Q18 and Q19, and the drive to the demodulator Q21 base. See Figures 6-2 and 6-3.

If the chopper operation is normal, check the input amplifier by looking at the unbalance at the collectors of Q12, and Q14 and Q15. If there is a defective component along the string of differential amplifiers, the unbalance will at some point reverse, indicating that the signal is not getting through.

f. Check the computer amplifier by performing the procedure of Section 6.3.2.2e. If this procedure can be performed, compare the voltage change at TP21 and TP22 as the input power is varied between -10 dBm and 0 dBm. The change at TP22 should be very close to twice the change at TP21.

g. Check the operation of the X15 amplifier. Connect a dc voltmeter to pin 6 of U4. At zero dBm input power, the voltage there should be zero. It should change by 1 volt for each 10 dB change in RF power. If not, be sure that the conditions of Section 6.3.2.2d are met. If they are, trouble in U4 or the associated circuits is indicated. If operation is normal, proceed to h.

h. Check U5 pin 6. Voltage should be zero at zero dBm input. The voltage should change by 1V for each 10 dB input change.

i. If the output of the calibrator is too low or gone entirely, first measure the voltage at the collector of Q23. If the voltage is between 0.6 and 4 V, check Q25. If not, look for trouble at Q23, Q24, or their associated components. If the calibrator output is too high, check CR11 or CR12, or Q24. Defective capacitors C46, C47, C51 or C52 can cause a squeezing of the oscillation.

j. If trouble is indicated in the digital display, connect a variable voltage source to terminal 29 of the display board. A precision supply, described in Section 6.3.1b,

is ideal. To determine if the absolute value circuit is working, perform the procedure of Section 6.3.2.1a and b. If you can perform the procedure go to step k.

k. Measure the voltage between TP13 and A1 pin 20. This voltage should be within a few millivolts of 5 volts. If not, check U15 and associated components.

l. Connect a jumper from A1U9 pin 13 to TP13; a sharp pointed probe or piece of wire is needed to contact the I.C. pin. Using an oscilloscope, monitor A1U8 pin 6. The waveform should be a staircase with 9 steps of 0.500 volts. See Figure 6-4. If operation is normal go to step m. If not, trouble is indicated in the D-A converter Q4 through Q11 or the logic-counter section of the display.

m. Examine the logic circuit for proper operation. Connect the external sync terminal of the oscilloscope to TP15. Set the trigger slope to +, and the trigger level control slightly positive. Connect the input probe to TP15 also. Set the sweep speed so that there is just one cycle of the square wave displayed. The first half should be the positive half; if not readjust the trigger control until it is. See Figure 6-5a. You will obtain a brighter picture if you connect a jumper from A1 pin 2 to TP13. Now remove the input probe from TP15 and examine the points shown in Figure 6-1 If the waveforms you obtain do not correlate with those shown, use the circuit diagram, Drawing 11568, to help you locate the components closest to the point where an error is discovered.

n. If all the tests so far have failed to show anything positive, begin a systematic check of the components associated with U5, U6, U7, and switch circuits S1 through S10.

o. Failure of one or more tubes to light can probably be traced to the circuits associated with Q13 through Q20, the +200 V power supply, or the logic circuits.

6.5 DETECTOR MAINTENANCE

WARNING

The detector element mounted in the detector body (see Figure 6-6) can be damaged if the special handling precautions noted below are not observed. Before removing, installing, or handling the detector element in any way be sure to read the precautions below.

6.5.1 DETECTOR ELEMENT HANDLING PRECAUTIONS.

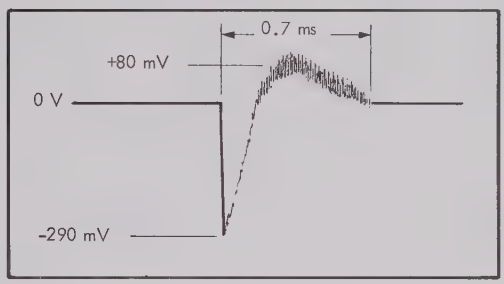
a. Before installing a detector element into the detector mount, discharge any static voltages that may exist between yourself and the mount by touching the mount.

b. When handing a detector element to another person, discharge static voltage by touching hands before passing the element.

c. Do not use ohmmeters to check the detector elements since the voltages and currents available from most such meters can easily damage the sensitive diodes used in these elements.

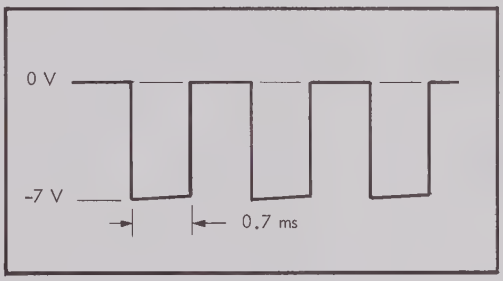
6.5.2 REPLACING THE DETECTOR ELEMENT

To replace the detector element, refer to Figure 6-6 for proper identification of the parts mentioned in this procedure.



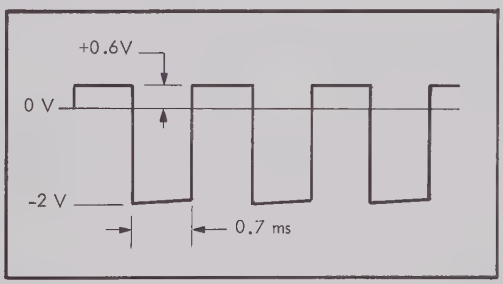
TP26 CHOPPER OUTPUT

FIGURE 6-1



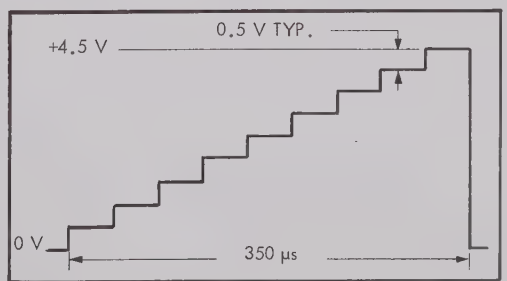
A2Q9 or A2Q10 COLLECTOR

FIGURE 6-2



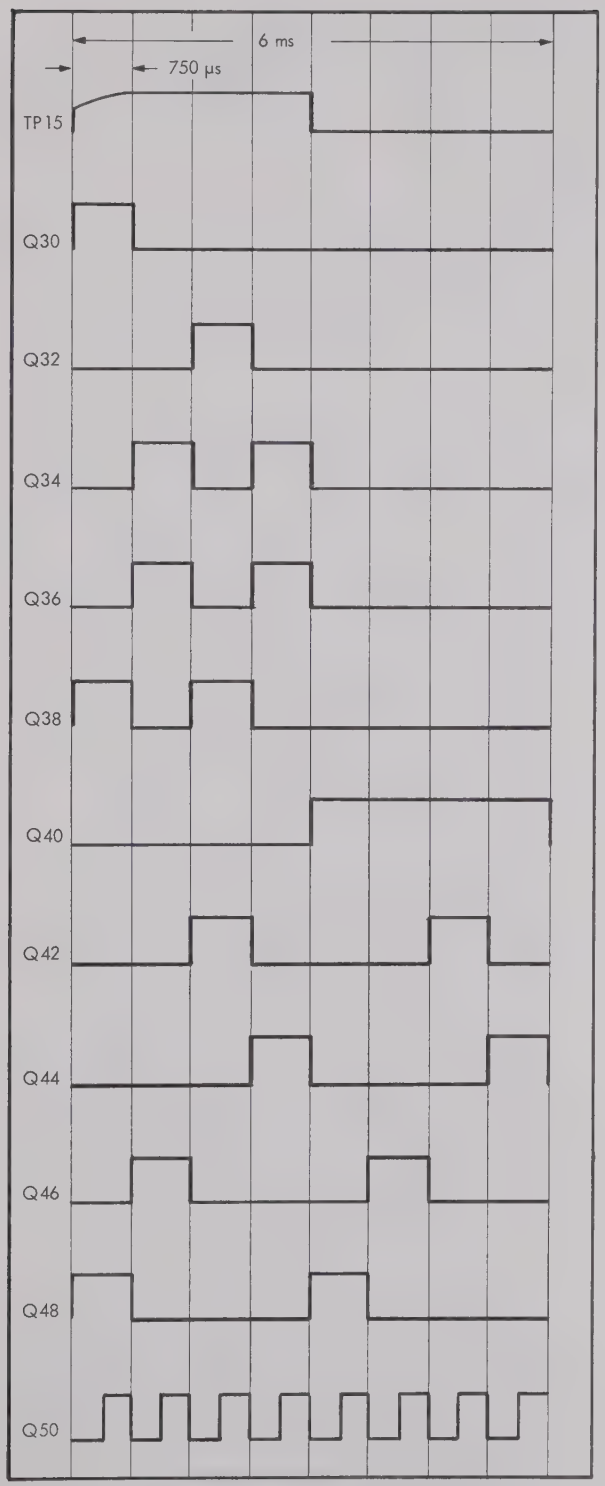
A2Q21 BASE

FIGURE 6-3



A1U8 PIN 6

FIGURE 6-4



LOGIC WAVEFORMS SHOWING RELATIVE "ON" TIMES FOR THE FET GATES

FIGURE 6-5

a. Unscrew the cap assembly from the body. In separating these parts, use a pair of pliers with plastic jaws or protect the parts with heavy paper or tape. To prevent undue strain on the cable, hold the cap assembly stationary and turn the body section to disassemble.

b. For assembly 11611, 11939 or 11855 unscrew the clamp and remove the insulator.

c. Remove the detector element, capsule spacer and capacitive washer.

d. Install the new capacitive washer, capsule spacer, and detector element in that order. Note that the polyiron side of the capsule spacer should be against the capacitive washer. Insert the resistive end of the detector element into the center contact inside the body.

CAUTION

When inserting the detector element, do not force the tip (resistive end) into the center conductor in the body as the fingers of the center conductor may be damaged.

e. For assembly 11611, 11939 or 11855 install the insulator with its small diameter counterbore toward the detector element. Screw in the clamp until it is snug.

f. Replace the cap assembly and tighten firmly.

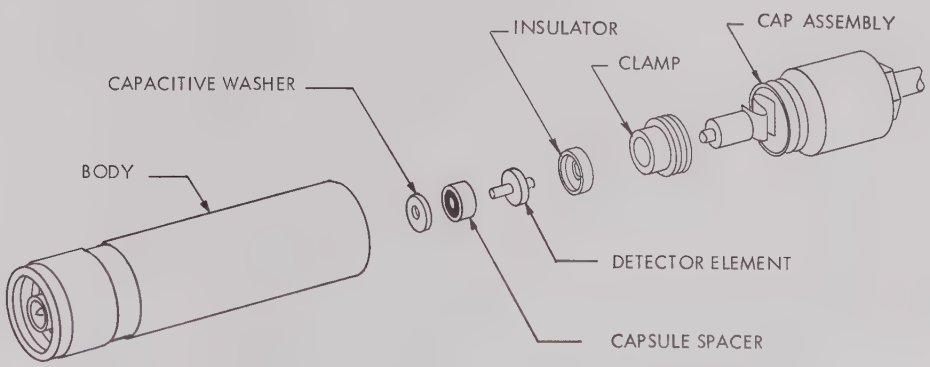
A metal film resistor is furnished with the detector replacement kit to replace A2R41 (input resistor) located in the front section of PC Board Assembly 11248. Check the value of A2R41 in the unit and change it only if the value of the replacement differs from the existing one in the unit.

6.6 REPLACEMENT OF SEMICONDUCTORS.

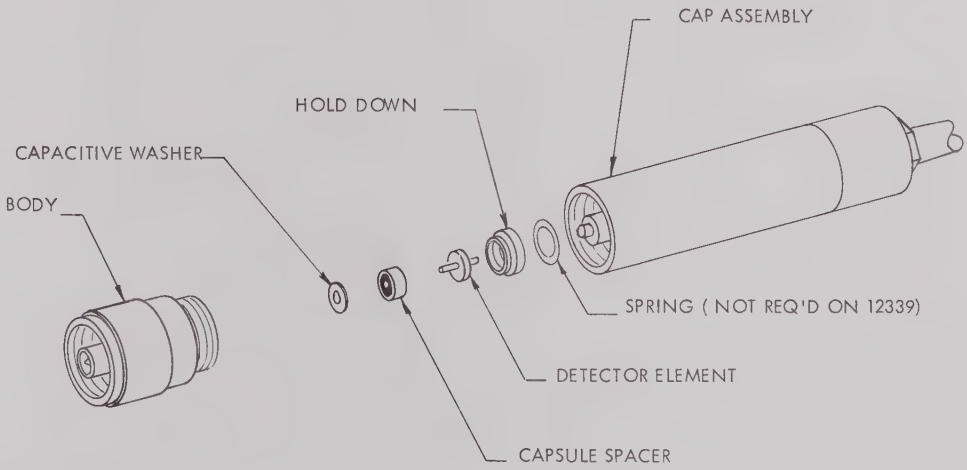
A variety of semiconductor devices is used in this instrument. The type numbers shown are either EIA registered numbers or manufacturer's numbers; these devices may be used for replacement purposes. Individual instruments may have equivalent devices of other manufacturers installed and the type number may not agree with those shown.

6.7 PARTS REPLACEMENT.

Lifting or removal of PC boards from the unit for parts replacement can be accomplished by taking the top and bottom covers off and removing one of the sides. Either side may be removed by unscrewing the five flathead screws on the side and the one front panel mounting screw located at the top. Remove the PC board by unscrewing the PC board mounting screws and sliding the board out the side.



Detector replacement in assembly 11611, 11939 and 11855



Detector replacement in assembly 12236, 12237 and 12339

DETECTOR

FIGURE 6-6

SECTION 7

SCHEMATIC DIAGRAMS

	LOG RF POWER METER	11869
A1	DIGITAL DISPLAY (3 sheets)	11568
A2	INPUT AMPLIFIER (3 sheets)	11249

SYM	REVISION	ECO	DATE

COMPUTER AMPLIFIER

+12.6V
R2 100
C1 .01
R3 100
Q1 FM3955
C2 .01
TP21
J1
THERMISTOR 10
R1 470K
U1 741C
R12 100K
MEDIUM LEVEL CAL
R13 162K 1%
R14 162K 1%
R15 100
C6 .01
U2 741C
R4 61.9K 1%
Q2 2N3646
CR1
R16 4.99K 1%
R17 500
HIGH LEVEL CAL
R18 348 1%
C7 .001
R85 4.7K
R5 61.9K 1%
R8 100
R10 100
R9 10K
LOW LEVEL CAL
R19 9.53K 1%
R6 100
R7 100
C4 .01
R11 10K
C8 .01
R20 100
-12.6V
J2
TP22
C3 .01
C5 100PF
Q4 2N3644
Q5 2N3646
Q3 2N3644
R37 10K
R38 1M
ZERO 16
J4
TP24
R39 10M
R40 10K
(OVEN)
R58 10
Q38 2N3646
TO S1-1B2-NO (SHEET 2)
S1-1A2
C18 10PF
J5
TP25
17
INPUT AMPLIFIER
* R41
R42 10.0K 1%
R45 10.0K 1%
R54 4.7K
R55 47
R57 4.7K
R59 220
C19 0.1
XTAL INPUT
18
TP23
J3
19
R43 4.7K
R44 68
R46 47
R56 47
C17 0.1
R53 2.2K
C15 .022
R47 47
Q15 2N3563
R60 47
Q16 2N4121
Q17 2N4121
Q12 SU2080
Q14 2N3563
S1-1A2
R61 6.8K
C16 330
R52 15K
+12.6V
R62 4.7K
R48 10K
ZERO CAL
R63 100K
Q13 2N3565
R64 10M
-12.6V
S1-1A1
R49 10K
CR2
CR3
R50 10
R51 6.8K
R65 22M
CR4
C20 .001
-12.6V
R66 100K
C25 0.1

CHOPPER DRIVE

R27 1K
R21 100K
C9 .01
R26 47K
R28 470K
C12 0.1
R33 47K
R30 220K
R31 220K
R22 680K
Q8 2N4250
C10 33PF
R34 33K
Q7 2N4250
R29 330K
Q10 2N3565
R35 220K
Q11 2N3565
Q9 2N3565
R23 220K
Q6 2N3565
R24 15K
R25 15K
R32 100K
R36 1K
-12.6V
C13 0.1

CHOPPER AMPLIFIER

INPUT ZERO
+12.6V
R72 100K
R75 100
R84 470K
Q18 3N138
Q19 3N138
R71 470K
R73 2.2K
R76 1.5K
R83 10K
C26 .01
C27 100PF
C30 .01
C21 .001
R70 11.0 1%
C33 .022
U3 709C
TP26
R74 4.7K
C28 0.1
J6
R69 100K
R82 220
Q20 2N4360
C31 100PF
Q21 2N3569
C22 0.1
C23 100PF
R81 4.7M
R67 100K
R68 10M
R78 4.7M
C32 1.0
C34 47PF
C24 0.1
C29 .01
R79 330
C35 .01
CR5
CR6
R77 100
R80 100
-12.6V
C25 0.1

ASSEMBLY 11248
REFERENCE DESIGNATORS ARE ABBREVIATED PREFIX WITH A2

SWITCH NO.	SWITCH POS.	MODE
S1	1	ZERO
	2	dBm CAL
	3	dBm

NOTE: 1. UNLESS SPECIFIED OTHERWISE, RESISTOR VALUES ARE IN OHMS AND ARE ±5% ¼ WATT. CAPACITOR VALUES ARE IN MICROFARADS.
2. ALL DIODES ARE IN4148.
3 * DENOTES FACTORY SELECTED VALUE.

FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES TOLERANCE .XX ± .015 .XXX ± .005	DRAWN Y.O.	4-23-71	PACIFIC MEASUREMENTS INCORPORATED PALO ALTO, CALIFORNIA
		ENG R.B.	9-22-71	INPUT AMPLIFIER
		PROD		DRAWING NO. 11249 REV F
	SCALE			SHEET 1 OF 3

ASSEMBLY 11248
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A2

SYM	REVISION	ECO	DATE

7 +12.6V
R87 220K
R91 *
C37 12
R92 15.0K 1%
R88 100K
R89 220K
R90 1.00K 1%
R93 1.00K 1%
C38 .01
C39 .01
R94 100
R95 100
R96 15.0K 1%
R97 9.53K 1%
R98 1K
U4 741C
X15 AMPLIFIER
dBm GAIN
dBm OFFSET
-12.6V
FROM S1-1A2 (SHEET 1)

R102 1M
R103 100K
R104 250K
CAL FACTOR ADJ
S1-2B1
R101 100
R99 4.7K
C40 .01
R100 100
U5 741C
OUTPUT AMPLIFIER
R105 220
R106 10.0K 1%
C42 .0047
C41 .01
R107 *
R159 4.7K
Q26 2N3565
Q22 2N3569
R158 1K
R108 100
S1-2A1
R110 5.00K .05%
S1-1B2

9 CAL FACTOR
5 GROUNDING SW
4 OVER RANGE
12 CAL OSC
6 ABSOLUTE OUTPUT
3
11
14 DVM

2
CALIBRATOR
C43 .01
R111 10
R112 2.2K
C44 0.1
C45 .01
R120 100
CR9 IN4148
CR10 IN4148
Q25 2N4121
R119 10
C46 .001
R113 9.76K 1%
Q23 TIS97
Q24 TIS97
R114 1K
10 mW ADJ
CR11 HPA 2900
C48 100PF
R118 220
C47 100PF
CR12 HPA2900
C49 100PF
C50 6.8PF
L1 0.47μH
C51 150PF
C52 470PF
C53 .01
R121 49.9 1%
1
44
43
C54 *
C55 100PF
L2 .33μH
C56 150PF
C57 33PF
L3 .33μH
C58 *
C59 100PF
R122 23.8 0.1%
R123 221 1%
R124 221 1%
C74 .01
42
41
C60 0.1
CAL OUTPUT

30MHZ L.P. FILTER

NOTE
1. UNLESS SPECIFIED OTHERWISE, ALL RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4WATT. CAPACITOR VALUES ARE IN MICROFARADS.
2. * SELECTED VALUES

MODEL	R91	R107
1036	15.0KΩ 1%	470Ω
1037	20.5KΩ 1%	4.7KΩ

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE
.XX ± .015
.XXX ± .005
SCALE

		DATE
DRAWN	YO	4-23-71
ENG	R.B.	9-22-71
PROD		

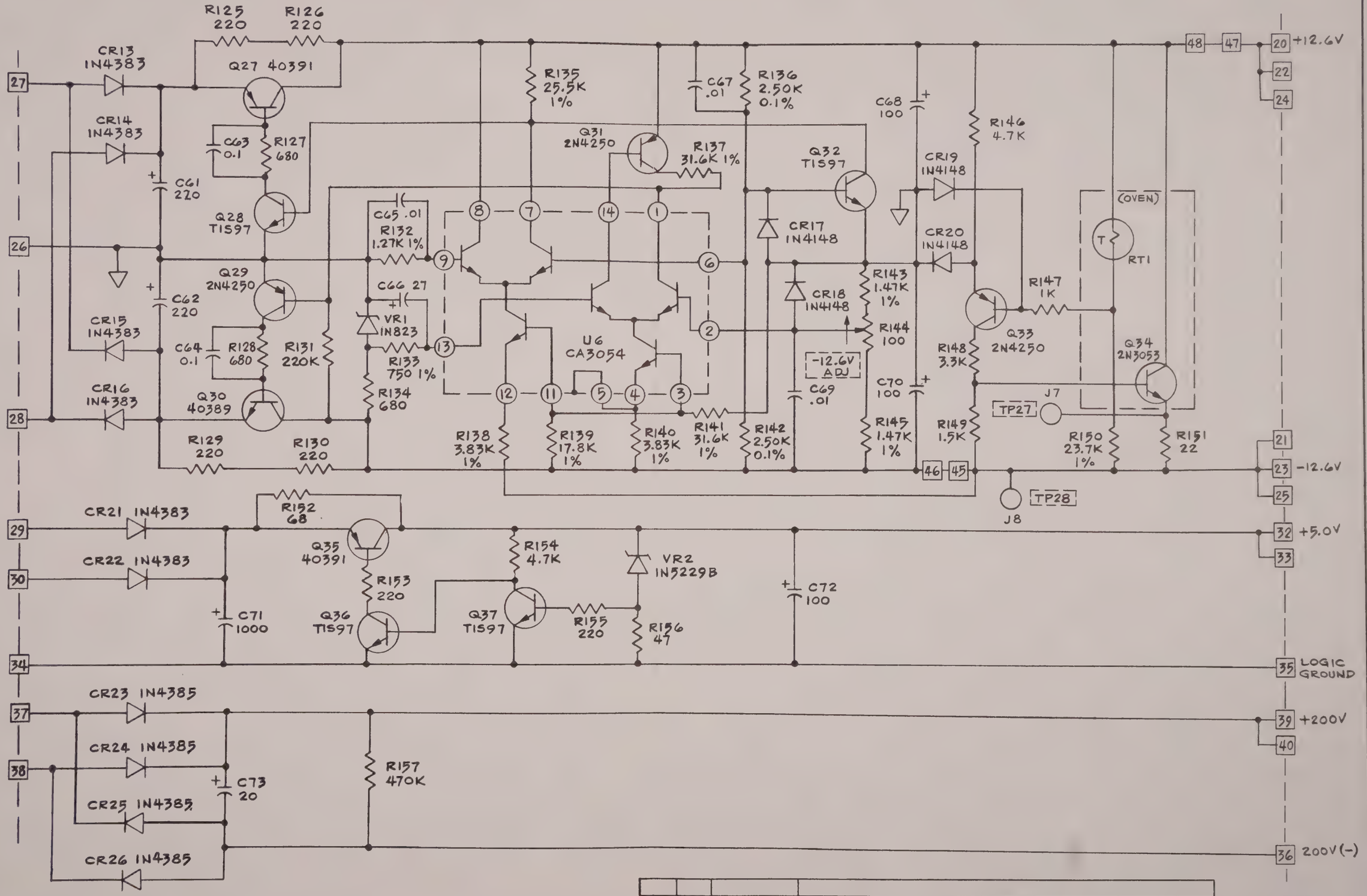
PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

INPUT AMPLIFIER

DRAWING NO. 11249
REV D
SHEET 2 OF 3

SYM	REVISION	ECO	DATE

ASSEMBLY 11248
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A2



NOTE
UNLESS SPECIFIED OTHERWISE, ALL RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES TOLERANCE XX ± .015 XXX ± .005 SCALE	DRAWN Y.O. 4-23-71 ENG R.B. 9-22 71 PROD	PACIFIC MEASUREMENTS INCORPORATED PALO ALTO, CALIFORNIA INPUT AMPLIFIER DRAWING NO. 11249 REV D SHEET 3 OF 3

ASSEMBLY 11567
REF DESIG ARE ABBREVIATED
PREFIX WITH A1

SYM	REVISION	ECO	DATE

+5V R3 2.2K
R1 47K R2 2.2K
Q1 2N 3569
C1 .001
C2 0.1
U1 SN7400 C3 .001
U1 SN7400
R4 2.2K
U2 SN7490
34 36 35 37 39 4 11 13 10 9 7 8 6 5 2
EXT TRIG INPUT
U3 SN7473 U3 SN7473 U4 SN7473 U4 SN7473
A B C D
R5 2.2K C5 .001
U1 SN7400 U1 SN7400
R6 2.2K
R7 4.7K R8 2.2M
Q3 T1897 Q2 2N3646
3 EXT TRIG GND
R9 1K C6 0.1
+5V R39 470 R40 470
CR4 U9 SN7400 U9 SN7400 CR5
CR6
R36 2.2K R38 470
SN7490 U10
C20 .001
U9 SN7400 R37 2.2K C27 .01
38 1 GND
TO PIN 7 U11
17
TO PIN 6 U11
18
TO PIN 4 U11
16
15
TO PIN 3 U11

ZERO ADJ
+12.6V
R10 1K R11 10 R12 100
C7 .0047
U5 302
R13 100 C8 .0047
-12.6V
R14 1K 0.1%
R15 10K 0.1%
C11 .0047
U6 301A
R17 100
-12.6V
TP11 J1
R22, 100
R23, 1K, .01%
C12, .001
R16, 100
C10 .0047
C9 6.8 pf
R18 10K .01%
R19 *
CR2 CR3
R20 1K 0.1%
C13 .0047
COMP. ADJ.
R25 1.5K
R26, 5K
U7 LM311
R21 1K 0.1%
R24 499 1%
C14 *
C15 .0047
R27 100
-12.6V
-5V
C18 .0047
U8 301A
C16 100 pf
C17 150 pf
R28 20K .1%
+12.6V
R30 100
R31 10K
R32 220
TP15 J5
S11
A
R34 100K D-A ZERO
R29 10K 1%
R33 10M
C19 0.1
R35 100
-12.6V

CR1
DIGITIZER INPUT TO C32 (+ ONLY) (SEE SH 2)
S1 S2 S3 S4 S5 S6 S7 S8 S9 S10
B C D
C21 .022
C22 .022
CR61
C23 .0047
C24 .0047
C25 .0047
C26 .0047

TP12 J2
R43 100K
+5V
R41 2.2K
CR7 CR8 CR9 CR10
R44 1.5K R48 1.5K R52 1.5K R55 1.5K
Q4 2N4250 Q6 2N4250 Q8 2N4250 Q10 2N4250
R45 50K .01%
R49 100K .01%
R53 25K .01%
R57 200K .01%
Q5 2N3569 Q7 2N3569 Q9 2N3569 Q11 2N3569
R47 49.9K 1%
R51 33.2K 1%
R58 28.7K 1%
TP13 J3
R42 1K
R46 680 R50 680 R54 680 R56 680
-5V

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS VALUE ARE IN OHMS, 1/4W, 5%.
2. ALL CAPACITORS VALUE ARE IN MF
3. FOR REF ON SWITCHES, S1 THRU S11 SEE SHEET 3.
4. ALL DIODES ARE IN4148.
5. * DENOTES FACTORY SELECTED VALUE.
6. SEE SHEET 2 FOR PARTS NOT USED IN ASSY 11567-2.

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES TOLERANCE .XX ± .015 .XXX .005	DRAWN Smac 1-14-71
	SCALE	ENG RB 3-17-71
		PROD

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

DIGTAL DISPLAY

DRAWING NO. 11568 REV D
SHEET 1 OF 3

STM	REVISION	ECO	DATE

+5V
+200V
+12.6V
-5V
-12.6V
R61 680
R62 1.5K
R63 47K
R64 47K
R154 2.2K
Q13, 2N5833
R65, 47K
R66 47K
R67 6.8K
Q14 2N5833
Q15 2N5833
Q16 2N5833
R68, 47K
R69 47K
Q17 2N5833
Q18 2N5833
R70, 47K
R71 47K
R72 6.8K
Q19 2N5833
Q20 2N5833
C29 .01
1N4148, (3 PLACES)
CR12 CR13
CR14 CR15 CR16
CR17 CR18 CR19
CR20 CR21 CR22
R155 2.2K
R156 2.2K
R157 2.2K
A B C D E
U11
SN74141
TO U10-12
TO U10-11
TO U10-9
TO U10-8
200V (-)
V1 V2 V3 V4
ANODE
DEC
R105 100
C37 .0047
C38 100
U15 741C
R99 2.49K 1%
R100 500
VR1 1N823
+FS. ADJ.
R101 422 1%
R102 681 1%
R103 470
C39 .0047
R104 100
R106 10
Q27 2N3644
DECIMAL INPUT 24
DECIMAL INPUT 23
DECIMAL INPUT 25
R73 10K
R74 10K
R75 10K
Q21 2N5833
Q22 2N5833
Q23 2N5833
R98 47K
C36 0.1
26 +200V
+5V 33
+12.6 22
R76 10
C30 0.1
R87, 5K, 0.05%
R94 10K
U12 741C
R77 10 1%
R78 100
-F.S. ADJ.
CR23 IN4148
R90 470
CR24, IN4148
R88 2.2K
Q24 TIS97
CR25 IN4148
R89 10K
R91 10K
TP14
J4
R108 1K
INPUT 29
30
R79 5K .05%
R80 10K
-BAL
R81 2.49K 1%
SIG. GND 32
C31 0.1
R82 1.5K
-12.6V 31
R83 10
C34, 0.1
C35, 0.1
TO BI PIN 3
C33 .22
R92 10K
U13 741C
CR26 IN448
CR27 IN4148
R84 2.49K 1%
+BAL
R85 1.5K
R86 10K
R93 2.49K 1%
DISPLAY FILTER 21
C32 100
POLARITY ON/OFF 28
U14
SN7474
R96 2.2K
R97 2.2K
R95 10K
Q25 2N5833
Q26 2N5833
R107 2.2K
V5
27 TO BCD INTERFACE
U14, SN7474
$\bar{D}$

ASSEMBLY 11567
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A1

NOTE
Q21, Q22, Q23, R73, R74, & R75 ARE NOT USED IN ASSY 11567-2.

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE
.XX ± .015
.XXX ± .005
SCALE

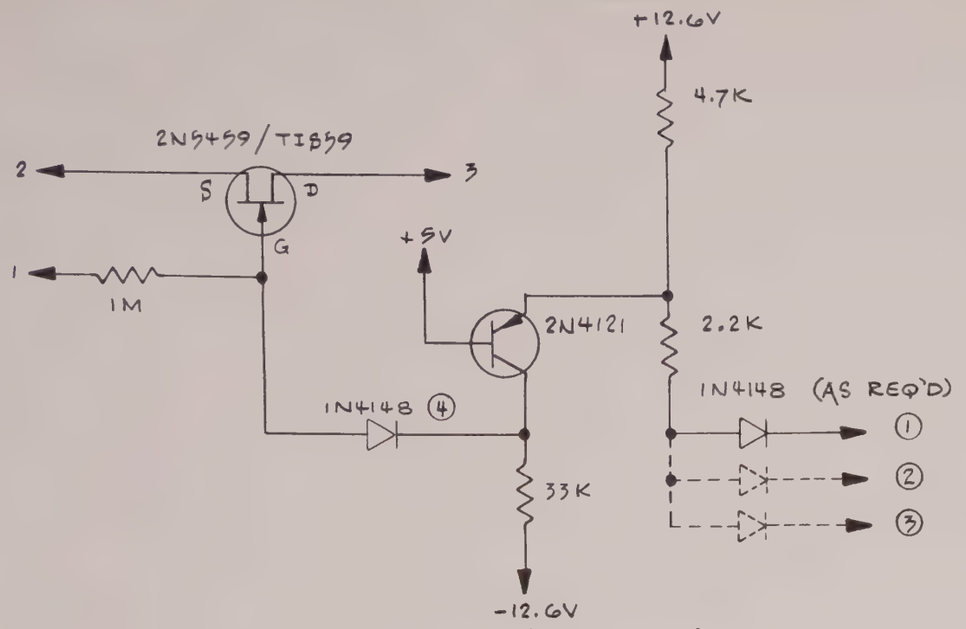
DRAWN	Smac	1-14-71
ENG	RB	3-17-71
PROD		

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

DIGITAL DISPLAY

DRAWING NO 11568
REV B
SHEET 2 OF 3

SYM	REVISION	ECO	DATE



SWITCH, S1 THRU S11 (TYP CIRCUIT)

	2N5459 TIB59	2N4121	1M	33K	4.7K	2.2K	1N4148 ①	1N4148 ②	1N4148 ③	1N4148 ④	
S1	Q30	Q31	R110	R111	R112	R113	CR28 $\bar{B}$	CR29 $\bar{C}$	CR30 $\bar{D}$	CR31 —	
S2	Q32	Q33	R114	R115	R116	R117	CR32 $\bar{B}$	CR33 C	CR34 $\bar{D}$	CR35 —	
S3	Q34	Q35	R118	R119	R120	R121	CR36 B	CR37 $\bar{D}$	— —	CR38 —	
S4	Q36	Q37	R122	R123	R124	R125	CR39 B	CR40 $\bar{D}$	— —	CR41 —	
S5	Q38	Q39	R126	R127	R128	R129	CR42 $\bar{B}$	CR43 $\bar{D}$	— —	CR44 —	
S6	Q40	Q41	R130	R131	R132	R133	CR45 D	— —	— —	CR46 —	
S7	Q42	Q43	R134	R135	R136	R137	CR47 $\bar{B}$	CR48 C	— —	CR49 —	
S8	Q44	Q45	R138	R139	R140	R141	CR50 B	CR51 C	— —	CR52 —	
S9	Q46	Q47	R142	R143	R144	R145	CR53 B	CR54 $\bar{C}$	— —	CR55 —	
S10	Q48	Q49	R146	R147	R148	R149	CR56 $\bar{B}$	CR57 $\bar{C}$	— —	CR58 —	
S11	Q50	Q51	R150	R151	R152	R153	CR59 A	— —	— —	CR60 —	

ASSEMBLY 11567
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A1

ITEM	REQD	PART NO.	DESCRIPTION
			LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE
XX ± .015
XXX ± .005

SCALE

DRAWN Smac 1-14-71
ENG RB 3-17-71
PROD

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

DIGITAL DISPLAY

DRAWING NO. 11568 REV A
SHEET 3 OF 3

SYM	REVISION	ECO	DATE

OVER RANGE
DS1
4 — 22

A4 ASSEMBLY 11610
RT1
R2 1K 1% 1/8W
R1 50
C1 .001
CAP
A3 CRYSTAL DETECTOR ASSEMBLY
INPUT

10 THERMISTOR
18 XTAL
19

T1
BRN 27
YEL 26
BRN 28
RED 38
RED 37
OR 29
BLU 34
OR 30
GN 31
BLK
YEL/BLK
R/BLK
GN/BLK
WH

A2
ASSEMBLY 11248
INPUT AMPLIFIER

7 — DBM CAL — R3 100KΩ
16 — ZERO — R2 100KΩ
9 — CAL FACTOR — R1 10KΩ
+12.6V 24
-12.6V 25

6 — J2 ANALOG OUTPUT
C1 .01μF
5 — S3 — INT / EXT
GROUNDING

41 — 42

200V(-) +200V +12.6V +5.0V -12.6V DVM

47 48 3 11 36 39 40 20 32 33 21 45 46 14 35 15 2 12 1 44

12 20 19 14 26 22 33 4 31 — 29 1 32

A1
ASSEMBLY 11567
DIGITAL DISPLAY

DISPLAY FILTER
S4 — OUT / IN
21
30

J3 CAL OUTPUT

2
3
TRIGGER
S5

27 16 17 18 15 34 35 37 36 11 10 7 6 13 39 1

INT SLOW
INT FAST
EXT

1 3 2 — 15 18 19 20 21 22 23 5 4 6 7 8 9 10 24 25 — 55 11 16 17

POLARITY BCD 8 BCD 4 BCD 2 BCD 1 A' B' CLOCK C' Ā B̄ D̄ Ā +5.0V

OPTION 01
ASSEMBLY 11824
BCD INTERFACE

(RESERVED) RANGE 1 RANGE 2 RANGE 4 POLARITY DATA READY DATA READY LOGIC COM. READ COMMAND +5V TEST

.01 .02 .04 .08 .1 .2 .4 .8 1 2 4 8 10 20 40 80

33 32 31 34 35 38 37 36 39 40 43 42 41 44 45 48 — 46 52 53 47 29 30 49 50 51 54 56

J4 — 4 5 6 7 8 9 10 11 12 13 21 22 23 24 25 26 — 28 29 30 27 3 20 2 18 36 1 14 — DATA OUTPUT

S2 VOLTS 115 230
S1 POWER ON
F1 0.5A
J1

ITEM	REQD	PART NO.	DESCRIPTION
			LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES TOLERANCE .XX ± .015 .XXX ± .005	DRAWN Y O — DATE 9-3-71
	SCALE	ENG R.B. — 9-22-71
		PROD

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

LOG RF POWER METER

DRAWING NO. 11869 — REV B
SHEET 1 OF 1

SECTION 8

REPLACEABLE PARTS LIST

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
		CHASSIS 11702 (For Model 1036) 11890 (For Model 1037)
C1	10000-11	Ceramic .01 µF +20% 100 V
DS1	11788-1	Lamp 14 V Red
F1	10064-2	Fuse 3AG 0.5A 250 V
J1	10052	AC Receptacle 3 Pin
J2	11689	Receptacle Type BNC (Insulated)
J3	11413	Panel Jack Type NUG1095A1U
R1	12233-1	Variable 10 KΩ ±10% 5W
R2	11676-1	Variable 100 KΩ ±20% 1/2 W
R3	11688-1	Variable 100 KΩ ±20% 25 Turns
S1	10057	Switch, Toggle
S2	11160	Switch, Slide 115-230
S3	10059	Switch, Slide DPDT
S4	10059	Switch, Slide DPDT
T1	11857	Transformer, Power
		DIGITAL DISPLAY PC BOARD ASSEMBLY 11567-2
A1C1	10000-4	Ceramic .001 µF ±20% 1000 V
A1C2	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A1C3	10000-4	Ceramic .001 µF ±20% 1000 V
A1C4		Not Used
A1C5	10000-4	Ceramic .001 µF ±20% 1000 V
A1C6	10007-7	Mylar 0.1 µF ±10% 200 V
A1C7	10000-6	Ceramic .0047 µF ±20% 500 V
A1C8	10000-6	Ceramic .0047 µF ±20% 500 V
A1C9	10001-9	Ceramic 6.8 pF ±5% 1000 V
A1C10	10000-6	Ceramic .0047 µF ±20% 500 V
A1C11	10000-6	Ceramic .0047 µF ±20% 500 V
A1C12	10000-4	Ceramic .001 µF ±20% 1000 V
A1C13	10000-6	Ceramic .0047 µF ±20% 500 V
A1C14		Factory Selected
A1C15	10000-6	Ceramic .0047 µF ±20% 500 V
A1C16	10000-1	Ceramic 100 pF ±5% 1000 V
A1C17	10000-12	Ceramic 150 pF ±20% 1000 V
A1C18	10000-6	Ceramic .0047 µF ±20% 500 V
A1C19	10000-10	Ceramic 0.1 µF +80% -20% 1000 V
A1C20	10000-4	Ceramic .001 µF ±20% 1000 V
A1C21	10007-5	Mylar .022 µF ±10% 200 V
A1C22	10007-5	Mylar .022 µF ±10% 200 V
A1C23	10000-6	Ceramic .0047 µF ±20% 500 V
A1C24	10000-6	Ceramic .0047 µF ±20% 500 V
A1C25	10000-6	Ceramic .0047 µF ±20% 500 V
A1C26	10000-6	Ceramic .0047 µF ±20% 500 V
A1C27	10000-7	Ceramic .01 µF ±20% 500 V
A1C28		Not Used
A1C29	10000-7	Ceramic .01 µF ±20% 500 V
A1C30	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A1C31	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A1C32	10787-10	Tantalum 100 µF ±20% 20 V
A1C33	10007-8	Mylar .22 µF ±10% 200 V
A1C34	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A1C35	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A1C36	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A1C37	10000-6	Ceramic .0047 µF ±20% 20 V
A1C38	10787-10	Tantalum 100 µF ±20% 20 V
A1C39	10000-6	Ceramic .0047 µF ±20% 500 V
A1C40		Not Used
A1C41		Not Used
A1C42		Not Used
A1CR1	10043-2	1N4148
A1CR2	10043-2	1N4148
A1CR3	10043-2	1N4148
A1CR4	10043-2	1N4148
A1CR5	10043-2	1N4148
A1CR6	10043-2	1N4148
A1CR7	10043-2	1N4148
A1CR8	10043-2	1N4148
A1CR9	10043-2	1N4148
A1CR10	10043-2	1N4148
A1CR11	10043-2	1N4148
A1CR12	10043-2	1N4148
A1CR13	10043-2	1N4148
A1CR14	10043-2	1N4148
A1CR15	10043-2	1N4148
A1CR16	10043-2	1N4148
A1CR17	10043-2	1N4148
A1CR18	10043-2	1N4148
A1CR19	10043-2	1N4148
A1CR20	10043-2	1N4148
A1CR21	10043-2	1N4148
A1CR22	10043-2	1N4148
A1CR23	10043-2	1N4148
A1CR24	10043-2	1N4148
A1CR25	10043-2	1N4148
A1CR26	10043-2	1N4148
A1CR27	10043-2	1N4148
A1CR28	10043-2	1N4148
A1CR29	10043-2	1N4148
A1CR30	10043-2	1N4148
A1CR31	10043-2	1N4148
A1CR32	10043-2	1N4148
A1CR33	10043-2	1N4148
A1CR34	10043-2	1N4148
A1CR35	10043-2	1N4148
A1CR36	10043-2	1N4148
A1CR37	10043-2	1N4148
A1CR38	10043-2	1N4148
A1CR39	10043-2	1N4148
A1CR40	10043-2	1N4148
A1CR41	10043-2	1N4148
A1CR42	10043-2	1N4148
A1CR43	10043-2	1N4148
A1CR44	10043-2	1N4148
A1CR45	10043-2	1N4148
A1CR46	10043-2	1N4148
A1CR47	10043-2	1N4148
A1CR48	10043-2	1N4148
A1CR49	10043-2	1N4148
A1CR50	10043-2	1N4148
A1CR51	10043-2	1N4148
A1CR52	10043-2	1N4148
A1CR53	10043-2	1N4148
A1CR54	10043-2	1N4148
A1CR55	10043-2	1N4148
A1CR56	10043-2	1N4148
A1CR57	10043-2	1N4148
A1CR58	10043-2	1N4148
A1CR59	10043-2	1N4148
A1CR60	10043-2	1N4148
A1CR61	10043-7	1N4148
A1CR62		Not Used
A1J1	10140-2	Test Jack, Yellow
A1J2	10140-2	Test Jack, Yellow
A1J3	10140-3	Test Jack, Black
A1J4	10140-2	Test Jack, Yellow
A1J5	10140-2	Test Jack, Yellow

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A1Q1	10017	2N3569
A1Q2	10018	2N3646
A1Q3	11507	TIS97 (TI)
A1Q4	11119	2N4250
A1Q5	10017	2N3569
A1Q6	11119	2N4250
A1Q7	10017	2N3569
A1Q8	11119	2N4250
A1Q9	10017	2N3569
A1Q10	11119	2N4250
A1Q11	10017	2N3569
A1Q12		Not Used
A1Q13	11692	2N5833
A1Q14	11692	2N5833
A1Q15	11692	2N5833
A1Q16	11692	2N5833
A1Q17	11692	2N5833
A1Q18	11692	2N5833
A1Q19	11692	2N5833
A1Q20	11692	2N5833
A1Q21		Not Used
A1Q22		Not Used
A1Q23		Not Used
A1Q24	11507	TIS97 (TI)
A1Q25	11692	2N5833
A1Q26	11692	2N5833
A1Q27	10023	2N3644
A1Q28		Not Used
A1Q29		Not Used
A1Q30	11585	TIS59 (TI)
A1Q31	10398	2N4121
A1Q32	11585	TIS59 (TI)
A1Q33	10398	2N4121
A1Q34	11585	TIS59 (TI)
A1Q35	10398	2N4121
A1Q36	11585	TIS59 (TI)
A1Q37	10398	2N4121
A1Q38	11585	TIS59 (TI)
A1Q39	10398	2N4121
A1Q40	11585	TIS59 (TI)
A1Q41	10398	2N4121
A1Q42	11585	TIS59 (TI)
A1Q43	10398	2N4121
A1Q44	11585	TIS59 (TI)
A1Q45	10398	2N4121
A1Q46	11585	TIS59 (TI)
A1Q47	10398	2N4121
A1Q48	11585	TIS59 (TI)
A1Q49	10398	2N4121
A1Q50	11585	TIS59 (TI)
A1Q51	10398	2N4121
A1R1	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R2	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R3	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R4	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R5	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R6	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R7	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R8	10013-65	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R9	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A1R10	10046-7	Variable Comp. 1 KΩ ±20% 1/4 W
A1R11	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A1R12	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A1R13	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A1R14	12449-19	Metal Film 1.00 KΩ ±0.1% 1/8 W
A1R15	12449-21	Metal Film 10.00 KΩ ±0.1% 1/8 W
A1R16	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A1R17	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A1R18	11695-2	Wirewound 10.00 KΩ ±.01% 1/8 W
A1R19		Factory Selected Value
A1R20	12449-19	Metal Film 1.00 KΩ ±0.1% 1/8 W
A1R21	12449-19	Metal Film 1.00 KΩ ±0.1% 1/8 W
A1R22	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A1R23	11695-1	Wirewound 1.00 KΩ ±.01% 1/8 W
A1R24	10015-140	Metal Rilm 499 Ω ±1% 1/4 W
A1R25	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A1R26	10046-4	Variable Comp. 5 KΩ ±20% 1/4 W
A1R27	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A1R28	12449-37	Metal Film 20.00 KΩ ±0.1% 1/8 W
A1R29	10015-7	Metal Film 10.0 KΩ ±1% 1/4 W
A1R30	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A1R31	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R32	10013-17	Carbon Film 2.20 Ω ±5% 1/4 W
A1R33	10013-73	Carbon Film 10 MΩ ±5% 1/4 W
A1R34	10046-10	Variable Comp. 100 KΩ ±20% 1/4 W
A1R35	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A1R36	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R37	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R38	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A1R39	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A1R40	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A1R41	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R42	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A1R43	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A1R44	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A1R45	11695-4	Wirewound 50.00 KΩ ±.01% 1/8 W
A1R46	10013-23	Carbon Film 680 Ω ±5% 1/4 W
A1R47	10015-133	Metal Film 49.9 KΩ ±1% 1/4 W
A1R48	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A1R49	11695-5	Wirewound 100.00 KΩ ±.01% 1/8 W
A1R50	10013-23	Carbon Film 680 Ω ±5% 1/4 W
A1R51	10015-188	Metal Film 33.2 KΩ ±1% 1/4 W
A1R52	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A1R53	11695-3	Wirewound 25.00 KΩ ±.01% 1/8 W
A1R54	10013-23	Carbon Film 680 Ω ±5% 1/4 W
A1R55	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A1R56	10013-23	Carbon Film 680 Ω ±5% 1/4 W
A1R57	11695-6	Wirewound 200.00 KΩ ±.01% 1/8 W
A1R58	10015-118	Metal Film 28.7 KΩ ±1% 1/4 W
A1R59		Not Used
A1R60		Not Used
A1R61	10013-23	Carbon Film 680 Ω ±5% 1/4 W
A1R62	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A1R63	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R64	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R65	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R66	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R67	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A1R68	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R69	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R70	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R71	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R72	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A1R73		Not Used
A1R74		Not Used
A1R75		Not Used
A1R76	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A1R77	10015-186	Metal Film 10.0 Ω ±1% 1/4 W
A1R78	10046-9	Variable Comp. 100 Ω ±20% 1/4 W
A1R79	10725-2	Wirewound 5.00 KΩ ±.05% 1/8 W
A1R80	10046-8	Variable Comp. 10 KΩ ±20% 1/4 W
A1R81	10015-47	Metal Film 2.49 KΩ ±1% 1/4 W
A1R82	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A1R83	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A1R84	10015-47	Metal Film 2.49 KΩ ±1% 1/4 W
A1R85	10015-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A1R86	10046-8	Variable Comp. 10 KΩ ±20% 1/4 W

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A1R87	10725-2	Wirewound 5.00 KΩ ±.05% 1/8 W
A1R88	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R89	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R90	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A1R91	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R92	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R93	10015-47	Metal Film 2.49 KΩ ±1% 1/4 W
A1R94	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R95	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A1R96	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R97	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R98	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A1R99	10015-47	Metal Film 2.49 KΩ ±1% 1/4 W
A1R100	11711-1	Variable Cermet 500 Ω ±20% 1/2 W 20 Turns
A1R101	10015-29	Metal Film 422 Ω ±1% 1/4 W
A1R102	10015-70	Metal Film 681 Ω ±1% 1/4 W
A1R103	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A1R104	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A1R105	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A1R106	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A1R107	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R108	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A1R109		Not Used
A1R110	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R111	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R112	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R113	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R114	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R115	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R116	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R117	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R118	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R119	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R120	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R121	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R122	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R123	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R124	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R125	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R126	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R127	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R128	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R129	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R130	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R131	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R132	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R133	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R134	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R135	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R136	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R137	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R138	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R139	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R140	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R141	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R142	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R143	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R144	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R145	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R146	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R147	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R148	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R149	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R150	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R151	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A1R152	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A1R153	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R154	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R155	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R156	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1R157	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A1U1	11270-1	SN7400N (TI) Quad 2 Input Nand Gate
A1U2	11270-10	SN7490N (TI) Decade Counter
A1U3	11270-8	SN7473N (TI) Dual J-K Master Slave Flip-Flop
A1U4	11270-8	SN7473N (TI) Dual J-K Master Slave Flip-Flop
A1U5	11690	LM302 (National) Voltage Follower
A1U6	11627	LM301A (National) Op Amp
A1U7	11691	LM311H (National) Voltage Comparator
A1U8	11627	LM301A (National) Op Amp
A1U9	11270-1	SN7400N (TI) Quad 2 Input Nand Gate
A1U10	11270-10	SN7490N (TI) Decade Counter
A1U11	11270-23	SN74141N (TI) BCD-To-Decimal Decoder/Driver
A1U12	11539	SN72741L Op Amp
A1U13	11539	SN72741L Op Amp
A1U14	11270-16	SN7474N (TI) Dual D-Type Flip-Flop
A1U15	11539	SN72741L Op Amp
A1V1	11707	Tube Numerals (Burroughs B5853S)
A1V2	11707	Tube Numerals (Burroughs B5853S)
A1V3	11707	Tube Numerals (Burroughs B5853S)
A1V4	11707	Tube Numerals (Burroughs B5853S)
A1V5	11708	Tube Polarity (Burroughs B5866S)
A1VR1	10045	Diode, Reference 1N823

INPUT AMPLIFIER
PC BOARD ASSEMBLY 11248

A2C1	10000-11	Ceramic .01 µF ±20% 100 V
A2C2	10000-11	Ceramic .01 µF ±20% 100 V
A2C3	10000-11	Ceramic .01 µF ±20% 100 V
A2C4	10000-11	Ceramic .01 µF ±20% 100 V
A2C5	10000-1	Ceramic 100 pF ±20% 1000 V
A2C6	10000-11	Ceramic .01 µF ±20% 100 V
A2C7	10000-4	Ceramic .001 µF ±20% 1000 V
A2C8	10000-11	Ceramic .01 µF ±20% 100 V
A2C9	10007-4	Mylar .01 µF ±10% 200 V
A2C10	10001-5	Ceramic 33 pF ±5% 1000 V
A2C11		Not Used
A2C12	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A2C13	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A2C14		Not Used
A2C15	10000-8	Ceramic .022 µF ±20% 500 V
A2C16	11173-1	Tantalum 330 µF ±20% 6 V
A2C17	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A2C18	10001-3	Ceramic 10 pF ±5% 1000 V
A2C19	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A2C20	10000-4	Ceramic .001 µF ±20% 1000 V
A2C21	10007-1	Mylar .001 µF ±10% 200 V
A2C22	10007-7	Mylar 0.1 µF ±10% 200 V
A2C23	10001-7	Ceramic 100 pF ±5% 1000 V
A2C24	10007-7	Mylar 0.1 µF ±10% 200 V
A2C25	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A2C26	10000-11	Ceramic .01 µF ±20% 100 V
A2C27	10000-1	Ceramic 100 pF ±20% 1000 V

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2C28	10007-7	Mylar 0.1 µF ±10% 200 V
A2C29	10000-11	Ceramic .01 µF ±20% 100 V
A2C30	10000-11	Ceramic .01 µF ±20% 100 V
A2C31	10000-1	Ceramic 100 pF ±20% 1000 V
A2C32	10787-5	Tantalum 1.0 µF ±20% 15 V
A2C33	10007-5	Mylar .022 µF ±10% 200 V
A2C34	10001-6	Ceramic 47 pF ±5% 1000 V
A2C35	10000-11	Ceramic .01 µF ±20% 100 V
A2C36		Not Used
A2C37	10787-2	Tantalum 12 µF ±20% 15 V
A2C38	10000-11	Ceramic .01 µF ±20% 100 V
A2C39	10000-11	Ceramic .01 µF ±20% 100 V
A2C40	10000-11	Ceramic .01 µF ±20% 100 V
A2C41	10000-11	Ceramic .01 µF ±20% 100 V
A2C42	10000-6	Ceramic .0047 µF ±20% 500 V
A2C43	10000-11	Ceramic .01 µF ±20% 100 V
A2C44	10007-7	Mylar 0.1 µF ±10% 200 V
A2C45	10000-11	Ceramic .01 µF ±20% 100 V
A2C46	10000-4	Ceramic .001 µF ±20% 1000 V
A2C47	10000-1	Ceramic 100 pF ±20% 1000 V
A2C48	10000-1	Ceramic 100 pF ±20% 1000 V
A2C49	10000-1	Ceramic 100 pF ±20% 1000 V
A2C50	10001-9	Ceramic 6.8 pF ±5% 1000 V
A2C51	10000-12	Ceramic 150 pF ±20% 1000 V
A2C52	10000-3	Ceramic 470 pF ±20% 1000 V
A2C53	10000-11	Ceramic .01 µF ±20% 100 V
A2C54		Factory Selected
A2C55	10001-7	Ceramic 100 pF ±5% 1000 V
A2C56	10001-15	Ceramic 150 pF ±5% 1000 V
A2C57	10001-5	Ceramic 33 pF ±5% 1000 V
A2C58		Factory Selected
A2C59	10001-7	Ceramic 100 pF ±5% 1000 V
A2C60		Not Used
A2C61	10003-6	Electrolytic 220 µF 35 V
A2C62	10003-6	Electrolytic 220 µF 35V
A2C63	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A2C64	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A2C65	10000-11	Ceramic .01 µF ±20% 100 V
A2C66	10787-3	Tantalum 27 µF ±20%
A2C67	10000-11	Ceramic .01 µF ±20% 100 V
A2C68	10787-10	Tantalum 100 µF ±20% 20 V
A2C69	10000-11	Ceramic .01 µF ±20% 100 V
A2C70	10787-10	Tantalum 100 µF ±20% 20 V
A2C71	10003-7	Electrolytic 1000 µF 35 V
A2C72	10787-10	Tantalum 100 µF ±20% 20 V
A2C73	10003-4	Electrolytic 20 µF 300 V
A2C74	10000-11	Ceramic .01 µF ±20% 100 V
A2CR1	10043-2	1N4148
A2CR2	10043-2	1N4148
A2CR3	10043-2	1N4148
A2CR4	10043-2	1N4148
A2CR5	10043-2	1N4148
A2CR6	10043-2	1N4148
A2CR7		Not Used
A2CR8		Not Used
A2CR9	10043-2	1N4148
A2CR10	10043-2	1N4148
A2CR11	11345	HPA 2900 (HP)
A2CR12	11345	HPA 2900 (HP)
A2CR13	10044-1	1N4383
A2CR14	10044-1	1N4383
A2CR15	10044-1	1N4383
A2CR16	10044-1	1N4383
A2CR17	10043-2	1N4148
A2CR18	10043-2	1N4148
A2CR19	10043-2	1N4148
A2CR20	10043-2	1N4148
A2CR21	10044-1	1N4383
A2CR22	10044-1	1N4383
A2CR23	10044-2	1N4385
A2CR24	10044-2	1N4385
A2CR25	10044-2	1N4385
A2CR26	10044-2	1N4385
A2J1	10140-2	Test Jack, Yellow
A2J2	10140-2	Test Jack, Yellow
A2J3	10140-3	Test Jack, Black
A2J4	10140-2	Test Jack, Yellow
A2J5	10140-2	Test Jack, Yellow
A2J6	10140-2	Test Jack, Yellow
A2J7	10140-2	Test Jack, Yellow
A2J8	10140-4	Test Jack, Blue
A2L1	10631-3	Coil, RF 0.47 µH ±10%
A2L2	10631-11	Coil, RF 0.33 µH ±10%
A2L3	10631-11	Coil, RF 0.33 µH ±10%
A2Q1	11432	FM3955 (National)
A2Q2	10018	2N3646
A2Q3	10023	2N3644
A2Q4	10023	2N3644
A2Q5	11457	2N3646 Selected
A2Q6	10019	2N3565
A2Q7	11119	2N4250
A2Q8	11119	2N4250
A2Q9	10019	2N3565
A2Q10	10019	2N3565
A2Q11	10019	2N3565
A2Q12	10207	SU2080 (Amelco)
A2Q13	10019	2N3565
A2Q14	10681	2N3563, Selected
A2Q15	10681	2N3563, Selected
A2Q16	10398	2N4121
A2Q17	10398	2N4121
A2Q18	10896	3N138
A2Q19	10896	3N138
A2Q20	10339	2N4360
A2Q21	10017	2N3569
A2Q22	10017	2N3569
A2Q23	11507	TIS97 (TI)
A2Q24	11507	TIS97 (TI)
A2Q25	10398	2N4121
A2Q26	10019	2N3565
A2Q27	11304	40391 (RCA)
A2Q28	11507	TIS97 (TI)
A2Q29	11119	2N4250
A2Q30	11303	40389 (RCA)
A2Q31	11119	2N4250
A2Q32	11507	TIS97 (TI)
A2Q33	11119	2N4250
A2Q34	10206	2N3053
A2Q35	11304	40391
A2Q36	11507	TIS97 (TI)
A2Q37	11507	TIS97 (TI)
A2Q38	10018	2N3646
A2R1	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R2	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R3	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R4	10015-25	Metal Film 61.9 KΩ ±1% 1/4 W
A2R5	10015-25	Metal Film 61.9 KΩ ±1% 1/4 W

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2R6	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R7	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R8	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R9	10046-8	Variable Comp. 10 KΩ ±20% 1/4 W
A2R10	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R11	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R12	11711-2	Variable 100 KΩ ±20% 20 Turns
A2R13	10015-34	Metal Film 162 KΩ ±1% 1/4 W
A2R14	10015-34	Metal Film 162 KΩ ±1% 1/4 W
A2R15	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R16	10015-65	Metal Film 4.99 KΩ ±1% 1/4 W
A2R17	10046-1	Variable Comp. 500 Ω ±20% 1/4 W
A2R18	10015-170	Metal Film 348 Ω ±1% 1/4 W
A2R19	10015-66	Metal Film 9.53 KΩ ±1% 1/4 W
A2R20	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R21	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R22	10013-59	Carbon Film 680 KΩ ±5% 1/4 W
A2R23	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R24	10013-39	Carbon Film 15 KΩ ±5% 1/4 W
A2R25	10013-39	Carbon Film 15 KΩ ±5% 1/4 W
A2R26	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A2R27	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R28	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R29	10013-55	Carbon Film 330 KΩ ±5% 1/4 W
A2R30	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R31	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R32	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R33	10013-45	Carbon Film 47 KΩ ±5% 1/4 W
A2R34	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R35	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R36	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R37	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R38	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R39	10013-73	Carbon Film 10 MΩ ±5% 1/4 W
A2R40	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R41		Factory Selected
A2R42	10015-7	Metal Film 10.0 KΩ ±1% 1/4 W
A2R43	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R44	10013-11	Carbon Film 68 Ω ±5% 1/4 W
A2R45	10015-7	Metal Film 10.0 KΩ ±1% 1/4 W
A2R46	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A2R47	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A2R48	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R49	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R50	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R51	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A2R52	10013-39	Carbon Film 15 KΩ ±5% 1/4 W
A2R53	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R54	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R55	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A2R56	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A2R57	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R58	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R59	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R60	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A2R61	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A2R62	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R63	10046-10	Variable Comp. 100 KΩ ±20% 1/4 W
A2R64	10013-73	Carbon Film 10 MΩ ±5% 1/4 W
A2R65	10142-4	Carbon Film 22 MΩ ±5% 1/4 W
A2R66	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R67	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R68	10013-73	Carbon Film 10 MΩ ±5% 1/4 W
A2R69	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R70	10015-122	Metal Film 11.0 Ω ±1% 1/4 W
A2R71	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R72	10046-10	Variable Comp. 100 KΩ ±20% 1/4 W
A2R73	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R74	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R75	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R76	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A2R77	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R78	10013-69	Carbon Film 4.7 MΩ ±5% 1/4 W
A2R79	10013-19	Carbon Film 330 Ω ±5% 1/4 W
A2R80	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R81	10013-69	Carbon Film 4.7 MΩ ±5% 1/4 W
A2R82	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R83	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R84	10013-57	Carbon Film 470 KΩ ±5%1/4 W
A2R85	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R86		Not Used
A2R87	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R88	10046-10	Variable Comp. 100 KΩ ±20% 1/4 W
A2R89	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R90	10015-19	Metal Film 1.00 KΩ ±1% 1/4 W
A2R91		Factory Selected
A2R92	10015-87	Metal Film 15.0 KΩ ±1% 1/4 W
A2R93	10015-19	Metal Film 1.00 KΩ ±1% 1/4 W
A2R94	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R95	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R96	10015-87	Metal Film 15.0 KΩ ±1% 1/4 W
A2R97	10015-66	Metal Film 9.53 KΩ ±1% 1/4 W
A2R98	10046-7	Variable Comp. 1 KΩ ±20% 1/4 W
A2R99	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R100	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R101	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R102	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R103	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R104	10046-11	Variable Comp. 250 KΩ ±20% 1/4 W
A2R105	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R106	10015-7	Metal Film 10.0 KΩ ±1% 1/4 W
A2R107		Factory Selected
A2R108	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R109		Not Used
A2R110	10725-2	Precision WW 5.00 KΩ ±.05% 1/8 W
A2R111	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R112	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R113	10015-58	Metal Film 9.76 KΩ ±1% 1/4 W
A2R114	10046-7	Variable Comp. 1 KΩ ±20% 1/4 W
A2R115	10015-105	Metal Film 6.19 KΩ ±1% 1/4 W
A2R116	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R117	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R118	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R119	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R120	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R121	10015-3	Metal Film 49.9 Ω ±1% 1/4 W
A2R122	11485-2	Metal Film 23.85 Ω ±0.1% 1/8 W
A2R123	11485-7	Metal Film 221 Ω ±0.1% 1/4 W
A2R124	11485-7	Metal Film 221 Ω ±0.1% 1/4 W
A2R125	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R126	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R127	10013-23	Carbon Film 680 Ω ±5% 1/4 W
A2R128	10013-23	Carbon Film 680 Ω ±5% 1/4 W
A2R129	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R130	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R131	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R132	10015-42	Metal Film 1.27 KΩ ±1% 1/4 W
A2R133	10015-49	Metal Film 750 Ω ±1% 1/4 W
A2R134	10013-23	Carbon Film 680 Ω ±5% 1/4 W
A2R135	10015-37	Metal Film 25.5 KΩ ±1% 1/4 W
A2R136	11485-11	Metal Film 2.50 KΩ ±0.1% 1/4 W
A2R137	10015-14	Metal Film 31.6 KΩ ±1% 1/4 W
A2R138	10015-32	Metal Film 3.83 KΩ ±1% 1/4 W
A2R139	10015-9	Metal Film 17.8 KΩ ±1% 1/4 W
A2R140	10015-32	Metal Film 3.83 KΩ ±1% 1/4 W
A2R141	10015-14	Metal Film 31.6 KΩ ±1% 1/4 W
A2R142	11485-11	Metal Film 2.50 KΩ ±0.1% 1/4 W
A2R143	10015-50	Metal Film 1.47 KΩ ±1% 1/4 W
A2R144	10046-6	Variable Comp. 200 Ω ±20% 1/4 W
A2R145	10015-50	Metal Film 1.47 KΩ ±1% 1/4 W

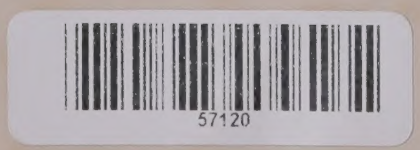
CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2R146	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R147	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R148	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A2R149	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A2R150	10015-28	Metal Film 23.7 KΩ ±1% 1/4 W
A2R151	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A2R152	10013-11	Carbon Film 68 Ω ±5% 1/4 W
A2R153	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R154	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R155	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R156	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A2R157	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R158	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R159	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2RT1	10209	Thermistor
A2S1	11679	Switch, Pushbutton
A2U1	11539	SN7274IL (TI) Op Amp
A2U2	11539	SN7274IL (TI) Op Amp
A2U3	10769	MC1709CG (Motorola) Op Amp
A2U4	11539	SN7274IL (TI) Op Amp
A2U5	11539	SN7274IL (TI) Op Amp
A2U6	11332	CA3054 (RCA) Dual Diff. Amp.
A2VR1	10045	Diode, Reference 1N823
A2VR2	11868	Diode, Reference 1N5229B
		CRYSTAL DETECTOR ASSEMBLY 11611
A3CR1	12220	Diode Replacement Kit consisting of the following items: Detector Element, Capsule Spacer, Capacitive Washer, Label, A2R41.
		CRYSTAL DETECTOR ASSEMBLY 11855
A3CR1	12050	Diode Replacement Kit consisting of the following items: Detector Element, Capsule Spacer, Capacitive Washer, Label, A2R41.
		CRYSTAL DETECTOR ASSEMBLY 11939
A3CR1	12051	Diode Replacement Kit consisting of the following items: Detector Element, Capsule Spacer, Capacitive Washer, Label, A2R41.
		CRYSTAL DETECTOR ASSEMBLY 12236
A3CR1	12372	Diode Replacement Kit consisting of the following items: Detector Element, Capsule Spacer, Capacitive Washer, Label, A2R41.
		CRYSTAL DETECTOR ASSEMBLY 12237
A3CR1	12373	Diode Replacement Kit consisting of the following items: Detector Element, Capsule Spacer, Capacitive Washer, Label, A2R41.
		CRYSTAL DETECTOR ASSEMBLY 12339
A3CR1	12375	Diode Replacement Kit consisting of the following items: Detector Element, Capsule Spacer, Capacitive Washer, Label, A2R41.
		CAP ASSEMBLY 11610
A4C1	11573-1	Ceramic .001 μ F ±20% 50 V
A4R1	10781	Film 50
A4R2	11518-2	Metal Film 1 KΩ±1% 1/8 W
A4RT1	10840	Thermistor 75 KΩ ±20%

SECTION

MANUAL CORRECTIONS

This section lists the corrections that must be incorporated in this manual to make it correspond to a particular instrument. The serial number of each instrument is prefixed by a code number. This code number is used to identify the applicable manual corrections for a particular instrument. When correcting this manual start with the corrections corresponding to the Code No. on the instrument. If a particular component has been changed more than one time, make only the first change encountered.

CODE NO.	CORRECTIONS	PM PART NO.	SECTION OF MANUAL AFFECTED
15	None		
16	Change A2Q3 and A2Q4 from 2N3644 (10023) to 2N2907	13533	7,8
	Change A2Q5 from 2N3646 (11457) to 2N2221	13534	7,8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